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Research Document 2005/018

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An assessment of the cod (*Gadus morhua*) stock in NAFO Divisions 2J3KL in March 2005

Évaluation du stock de morue (*Gadus morhua*) dans les divisions 2J3KL de l'OPANO, en mars 2005

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ISSN 1499-3848 (Printed / Imprimé)
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Canada

2007-00404

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ABSTRACT

The directed commercial fishery for northern (2J3KL) cod was closed in 1992, reopened for small boats in the inshore alone during 1998-2002, and closed again in 2003. Landings in 2003 came mainly from a mass mortality of cod in Smith Sound during April, and landings in 2004 were mainly from by-catch during a winter (blackback) flounder fishery in summer. Because of differences in the dynamics of offshore and inshore populations of northern cod since the mid-1990s, information is provided for the offshore and inshore separately. Populations in the offshore remain broadly distributed at very low density. The indices of biomass from research bottom-trawl surveys in autumn (2J3KL) and spring (3L only) are at less than 2% of their levels during the 1980s. Recruitment in the offshore has been very low and total mortality has been very high since at least the mid-1990s. Few fish survive beyond age 5. In the inshore, catch rates in sentinel surveys (1995-2004) and commercial fisheries (1998-2002), as well as cod by-catch in fisheries targeted at other species (2003-2004), indicate that there has been relatively few cod in 2J and northern 3K since at least the mid-1990s. However, there have been high catch rates at various times and places in southern 3K and in 3L. Inshore catch-rate indices from linetrawl and gillnet sentinel surveys increased from 1995 to a peak in 1997 and 1998 respectively, declined by the early 2000s, and then increased during recent years to levels similar to those in 1995. For the purpose of this assessment, the inshore is subdivided into three areas: 1) a northern area (2J and northern 3K) that contains relatively few cod; 2) a central area (southern 3K and northern 3L) where most of the resident inshore fish are located; and 3) a southern area (southern 3L) that is, at present, largely dependent on cod that overwinter in inshore and offshore areas of 3Ps, move into southern 3L in the spring-summer and return to 3Ps in the autumn. A sequential population analysis (SPA) was conducted for the resident cod in the inshore central area. SPA estimates indicate that spawner biomass in this area increased from 10,000 t in 1995 to 22,000 t in 1998, declined during 1998-2002 (when there was a commercial fishery) to 7,000 t in 2003, and has subsequently increased to 13,000 t by the beginning of 2005. The estimate of age 4+ biomass at the beginning of 2005 is about 20,000 t. Fishing mortality increased from 1998 to a peak of about 35% in 2001 and 2002 and has subsequently declined to relatively low levels. Deterministic projections from 2005 to 2008 were conducted for the inshore central area under three annual catch options and three recruitment assumptions (low, medium, high). No such projections could be performed for the northern and southern areas. The inshore northern area appears to have very low densities of cod. Any catch option would likely impose high fishing mortality and further reduce stock size in this area. The inshore southern area is primarily dependent on seasonal immigration of fish, the magnitude of which cannot be predicted. Therefore, the effect of removals of various levels cannot be estimated. There is a risk that fishing in the inshore will impede recovery in the offshore. The spawner biomass of the stock as a whole remains far below any conservation limit reference level as generally applied through the precautionary approach to fisheries management. Although such a level has not been defined precisely for 2J3KL cod, it is anticipated to lie above 300,000 t.

RÉSUMÉ

La pêche dirigée de la morue du Nord (2J3KL) a été fermée en 1992, rouverte aux petits bateaux côtiers seulement de 1998 à 2002, puis fermée à nouveau en 2003. Les débarquements en 2003 étaient attribuables principalement à une mortalité massive de morues survenues dans le bras Smith, en avril et, en 2004, aux prises accessoires d'une pêche de la plie rouge, en été. En raison des différences constatées dans la dynamique des populations des eaux extracôtières et des eaux côtières depuis le milieu des années 1990, l'information concernant ces eaux est présentée séparément. La morue du large demeure répartie sur un vaste territoire marin, mais à très faible densité. Les indices de biomasse provenant des relevés de recherche au chalut de fond effectués en automne (2J+3KL) et au printemps (3L seulement) se situent à moins de 2 % des niveaux des années 1980. Le recrutement dans les eaux extracôtières a été très faible et la mortalité totale a été très élevée depuis au moins le milieu des années 1990. Peu de poissons dépassent l'âge 5. Dans les eaux côtières, les taux de prise constatés dans les relevés par pêche sentinelle (1995-2004) et les pêches commerciales (1998-2002), ainsi que les prises accessoires de morue au cours des pêches dirigées vers d'autres espèces (2003-2004) indiquent qu'il y a eu relativement peu de morue dans 2J et dans le nord de 3K depuis au moins le milieu de la décennie 1990. Cependant, on a enregistré des taux de prise élevés à divers moments et endroits dans le sud de 3K et dans 3L. Les indices des taux de prise en eaux côtières dérivés des relevés par pêche sentinelle à la palangre et au filet maillant ont grimpé à partir de 1995 pour culminer, respectivement, en 1997 et en 1998, diminuer au début des années 2000, pour ensuite s'élever de nouveau au cours des dernières années et atteindre des niveaux semblables à ceux de 1995. Aux fins de la présente évaluation, les eaux côtières sont subdivisées en trois zones : 1) la zone du nord (2J et nord de 3K), qui contient relativement peu de morues; 2) la zone du centre (sud de 3K et nord de 3L), où se trouvent la plupart des poissons résidents des eaux côtières; 3) la zone du sud (sud de 3L), maintenant en grande partie dépendante de la morue qui hiverne dans les eaux côtières et extracôtières de 3Ps, se déplace vers le sud de 3L au printemps et en été, et revient vers 3Ps à l'automne. Une analyse séquentielle de la population (ASP) a été menée sur la morue résidente de la zone côtière du centre. Les estimations établies avec l'ASP indiquaient que la biomasse du stock reproducteur de cette zone était passé de 10 000 t en 1995 à 22 000 t en 1998, qu'elle avait diminué de 1998 à 2002 (lorsqu'une pêche commerciale a eu cours) pour s'établir à 7 000 t en 2003, puis qu'elle avait par la suite atteint 13 000 t au début de 2005. L'estimation de la biomasse des individus d'âge 4+ au début de 2005 est d'environ 20 000 t. La mortalité par la pêche s'est accrue à partir de 1998 pour atteindre un sommet d'environ 35 % en 2001 et en 2002 et descendre par la suite jusqu'à des niveaux relativement bas. On a établi des projections déterministes pour la zone côtière du centre pour la période s'échelonnant de 2005 à 2008, en utilisant encore une fois trois scénarios d'exploitation annuels et trois hypothèses de recrutement (faible, moyen, élevé). Aucune projection semblable n'a pu être réalisée pour les zones du nord et du sud. La zone côtière du nord semble présenter des densités de morue très faibles. Tous les scénarios d'exploitation étudiés engendreraient sans doute une mortalité par la pêche élevée et réduiraient davantage le volume des stocks dans cette zone. La zone côtière du sud dépend principalement de la migration saisonnière des poissons, dont l'ampleur ne peut être prévue. En conséquence, on ne peut évaluer l'effet des divers scénarios de prélèvement. Il est possible que la pêche menée dans les eaux côtières empêche le rétablissement dans les eaux extracôtières. Dans l'ensemble, la biomasse génitrice du stock de morue demeure de beaucoup inférieure à la limite propre à assurer la conservation des stocks que l'on applique généralement selon l'approche de précaution à la gestion des pêches. Bien qu'un tel niveau n'ait pas été défini avec précision pour la morue de 2J+3KL, on prévoit qu'il se situera au-dessus de 300 000 t.

1 Introduction

The northern (2J3KL) stock of Atlantic cod (*Gadus morhua*) occupies the area from the southern Labrador Shelf to the northern Grand Bank (Fig. 1a-c), where it occurs from the coast to 500-600 m, and occasionally to 900 m, on the upper continental slope. Historically, much of the cod overwintered near the shelf break in 300-500 m from Hamilton Bank in Div. 2J to the Nose of the Bank in Div. 3L. At some time in the spring most of these fish moved onto the shelf, and many of them migrated during late spring and summer into the shallow, coastal waters where they fed on capelin (*Mallotus villosus*) that had approached the coast to spawn (Templeman 1966). The cod then moved back across the shelf during the autumn. Not all cod had this offshore-inshore migration pattern. For example, some cod moved during summer to feeding areas on the plateau of Grand Bank. Others spent the whole year in inshore waters, moving from deep inlets during winter to shallow feeding areas in summer.

The northern cod has been exploited for centuries (Lear and Parsons 1993; Hutchings and Myers 1995; Lear 1998). Annual landings increased through the 18th and 19th centuries to about 300,000 tonnes during the early decades of the 20th century. The early fishery was limited to shallow water. Deep waters ceased to be refugia in the 1950s, when longliners were introduced to nearshore waters and distant water trawlers from Europe located and exploited dense aggregations of cod overwintering along the shelf break. Total landings escalated from 360,000 t in 1959 to 810,000 t in 1968 (Table 1; Fig. 2), and then plummeted to 140,000 t in 1978. Mathematical reconstruction of the population in later years (e.g. Bishop et al. 1993) indicated that this severe overfishing had caused a decline in biomass (ages 3 and older) from about 3,000,000 t in 1962 to about 500,000 t in 1978. The landings by distant water fleets declined substantially when Canada declared a 200 mile fishing zone in 1977. With the reduced fishing mortality, improved recruitment and an increase in individual growth rate, the population biomass started to rise. Canadian trawlers soon replaced the non-Canadian fleets on the winter fishing grounds, and catches once again rose to above 200,000 t. In 1988-1989 it was recognized that the stock size had been overestimated for several years, and that fishing mortality during the 1980s had been higher than intended. Quotas were reduced, but not sufficiently to prevent an increase in fishing mortality. In addition, oceanographic conditions became particularly severe during the early 1990s following two decades of low temperatures (Drinkwater 2002). The survey index declined precipitously in the early 1990s. The stock appeared to be declining rapidly, and in July 1992 Canada declared a moratorium on directed cod fishing. The survey index continued to decline, reaching an extremely low level by 1994. There has been almost no sign of improvement in the offshore during the subsequent decade.

After the stock as a whole collapsed in the early 1990s, it became clear that some aggregations of cod could still be found inshore. This engendered much interest in the stock affinities of these inshore fish. Numerous studies have indicated the likelihood of substock structure within the northern cod stock complex (see, for example, overviews by Lear 1986; deYoung and Rose 1993; Smedbol and Wroblewski 2002), and several sources of information support the hypothesis that fish overwintering inshore are functionally distinct from populations in the offshore (reviewed by Lilly et al. 1999). Genetic studies suggest that the northern cod conforms to an isolation-by-distance structure, with cod from more distant locations tending to be more distinct (Beacham et al. 2002). There appear to be differences between the inshore and the offshore, and among various areas of the offshore (Ruzzante et al. 1998; Beacham et al. 2002; but see Carr et al. 1995). Subpopulation structure at the level of individual bays is less strongly supported. Tagging studies conducted during the collapse period indicate that the inshore of 3KL is currently inhabited by at least two groups of cod: (1) a northern resident coastal group in northern 3L and southern 3K and (2) a migrant group from inshore and offshore areas of 3Ps that moves into 3L during late spring and summer and returns to 3Ps during the autumn. A third group, the migrants from offshore 2J3KL that historically supported the bulk of the inshore catch, appears to contribute little if any biomass to inshore waters during summer.

Attention must be drawn to one specific portion of the inshore. Gilbert Bay in southern Labrador (52°35' N; 56°00' W) has been shown to have a resident population of cod (Green and Wroblewski 2000; Morris and Green 2002) that is genetically distinct from other cod in the 2J3KL area (Ruzzante et al. 2000; Beacham et al. 2002). Population biomass has been estimated at less than 70 t (Morris et al. 2003). Gilbert Bay has been designated an Area of Interest, which is a step along the way to becoming a Marine Protected Area (MPA). Because of its small size, limited distribution and genetic distinctiveness, the Gilbert Bay population is not considered further in the present assessment of 2J3KL cod. No other resident population of cod has yet been identified along the Labrador coast (Morris and Green 2002).

The inshore populations of 3KL appear to have been more productive than the offshore populations of 2J3KL since at least the mid-1990s. In 1998 a directed fishery was reopened for small (< 65 feet) vessels operating in the inshore, but the inshore populations declined during the next few years, and all directed fishing was closed once again in 2003.

Assessments of the status of 2J3KL cod have been conducted since 1972 (Bishop and Shelton 1997). The basis for the computation of population size had been sequential population analysis (SPA) of the stock as a whole. These analyses became problematic during the early 1990s because of a poor fit between model output and the index of abundance derived from the DFO bottom-trawl surveys. Attempts at fitting whole stock SPAs were continued during the latter half of the 1990s and early 2000s (Lilly et al. 2003), but the models were considered to be only "illustrative" of the population dynamics, and not sufficiently well estimated to allow the projection of population size. In addition to the poor model fit in the early 1990s, a second problem arose during the mid-1990s when it became clear that the inshore populations were more productive than populations in the offshore. The landings during 1998-2002 came almost entirely from the inshore, and included many fish of ages and sizes beyond those captured in the offshore surveys. It was felt that the offshore bottom-trawl index was not representative of the inshore populations and was not appropriate for tuning the SPA.

Since the late 1990s, information on the status of 2J3KL cod has been presented for the offshore and inshore separately, without losing sight of the severely depleted status of the stock as a whole (Lilly et al. 2003). The most recent full assessment of stock status, conducted during February 2003 (DFO 2003; Lilly et al. 2003; Rice and Rivard 2003), continued this approach. The status of cod in the offshore was assessed on the basis of abundance/biomass indices from the DFO bottom-trawl surveys in 2J3KL in autumn and 3L in spring, and from hydroacoustic studies in specific areas. The status of cod in the inshore was assessed on the basis of indices of abundance/biomass from the sentinel surveys, hydroacoustic surveys in Smith Sound, exploitation rates and biomass estimates from tagging studies, catches from the commercial and recreational fisheries, and catch rates from the commercial fishery. A new SPA was constructed based on catches and indices from the inshore alone.

Because the fishery had been closed indefinitely in 2003, only an update of stock status was provided in 2004 (DFO 2004; Lilly et al. 2004). This was based simply on a review of by-catch landings in 2003 and an appraisal of major indices of stock abundance. These indices, which were analyzed in an age-aggregated form, were the bottom-trawl surveys in the offshore, the sentinel surveys in the inshore, and the hydroacoustic survey of Smith Sound.

The present document provides information in support of the regional assessment in March 2005 (DFO 2005). Specific objectives for the assessment are provided in Appendix 1. To address these objectives, the assessment reviewed information on stock structure and data from research bottom-trawl surveys, sentinel surveys (Maddock Parsons and Stead 2005), prerecruit surveys (Gregory et al. 2006), tagging studies (Brattey and Healey 2005), a telephone survey of fish harvesters (Jarvis and Stead 2005), and catches from commercial and recreational fisheries in the inshore (1995-2004). A sequential population analysis was conducted for a portion of the inshore area.

2 The fishery

2.1 Nominal catches prior to the 1992 moratorium

Landings from this stock increased during the late 1950s and early 1960s and peaked at just over 800,000 t in 1968 (Table 1; Fig. 2). Landings then declined rapidly to a minimum of 139,000 t in 1978, increased to a plateau of approximately 250,000 t in the mid- to late 1980s and then declined very quickly in the early 1990s. The portion of the landings coming from each of the Divisions changed over time. During the 1960s, when the fishery was primarily by non-Canadian fleets (Fig. 2), landings were taken mainly from Divisions 2J and 3L (Fig. 3). Division 3K became prominent in the mid-1970s. Landings from Division 2J were relatively small in the mid-1980s. Division 3L dominated from the mid-1980s until the moratorium in 1992.

The fixed gear landings (Table 2; Fig. 4) increased from just 41,000 t in 1975 to a peak of 113,000 t in 1982, declined to 74,000 t in 1986, and increased again to a peak of 117,000 t in 1990, just 2 years before declaration of the moratorium. Some of the increase in the late 1980s was due to a resurgence of gillnet landings in southern Division 2J and trap landings in Division 3L, but much was due to an expansion of the gillnet fishery to the Virgin Rocks and other offshore areas in Division 3L (Table 3; Fig. 5).

Landings declined to just 61,000 t in 1991. The commercial fishery was closed in July 1992 and only 12,000 t were landed that year.

2.2 Management advice, TACs and catches during 1992-2002

A summary of management advice, TACs and landings from various sources during the period from just before imposition of the moratorium on commercial fishing in July 1992 to the end of 2002 is provided by Lilly et al. (2003). A summary of management measures during 1996-2002 is provided in Appendix 2.

Landings during 1993-1997 came from by-catches in fisheries directed at other species, food/recreational fisheries, and DFO-industry sentinel surveys that started in 1995 (Table 2; Fig. 6).

A small index/commercial fishery limited to fixed gear deployed from small (< 65 feet) vessels commenced in 1998. Landings from 1998 to 2002 came from directed cod fisheries, by-catches, sentinel surveys and food/recreational fisheries (Table 2; Fig. 6).

Note that a new fishing season (April 1 to March 31) was put in place for 2000/2001 and subsequent years. However, only very small by-catches have been reported during the first three months of any year since the mid-1990s, so it is convenient to continue to refer to the fishery year as the calendar year in which the first 9 months of the fishery season occurred (e.g. the 2001/2002 fishery season will be referred to simply as 2001).

2.3 Landings during 2003 and 2004

The whole of the 2J3KL area was again closed to directed commercial and recreational fisheries in April 2003.

Landings during 2003

Reported landings during 2003 were approximately 880 t from commercial fisheries and 90 t from the sentinel surveys, for a total of 970 t. Landings from all sources are presented by gear, unit area and month in Table 4a. Gillnets contributed 17% by weight, small mesh gillnets from the sentinel surverys 1%, linetrawls 1% and handlines 81%. As described below, only a very small proportion of the catch attributed to handline was actually taken by handline.

Most (780 t) of the commercial catch during 2003 came from a mass mortality of cod in Smith Sound, Trinity Bay, during April. The exact cause of the event remains uncertain, but it was clearly associated with unusually cold water within the Sound (Colbourne et al. 2003). The cod were collected from the surface of the water by gaff and dipnet. Many of these fish were frozen, whereas others were torpid but still alive. The fish were generally large, with a high proportion in the range 55-85 cm.

NOTE: The landings of cod from Smith Sound in April 2003 are, at the time of writing, entered into DFO's statistical data base against the code for handline. It is emphasized that these fish were not caught by handline. They were collected from the surface with either gaff or dipnet. It is also somewhat uncertain whether these fish should be considered

commercial landings or natural mortality. A high proportion of the fish were dead when collected from the surface, but many, especially during the second half of the event, were alive when taken from the water.

The rest of the reported catch was by-catch in fisheries directed at other species. Most (84 t) of this came from gillnets set for winter (blackback) flounder. The bulk of this catch came from Bonavista Bay and Trinity Bay in July.

There are no estimates of discards from inshore fisheries. In addition, there are no estimates of the quantity of cod taken in illegal fishing, but such fishing is known to exist.

The by-catch from Canadian trawlers fishing offshore was 3 t.

The catch by non-Canadian trawlers outside the 200 nautical mile limit on the Nose of the Bank (Div. 3L) was 23 t.

Landings during 2004

The moratorium on directed commercial and recreational fishing for cod remained in effect during 2004. However, fishery management regulations (Appendix 3) were changed for 2004 such that individual fish harvesters were limited to a maximum by-catch of 2000 pounds (907 kg) in any and all groundfish fisheries. In addition, for the winter (blackback) flounder fishery, the incidental catch of cod was not to exceed 20% or 300 pounds per day. Many harvesters took much or all of their 2000 pound cod limit while directing for winter flounder, and in many cases the catch of winter flounder was much less than the catch of cod. The gillnet mesh size in the winter flounder fishery was 6½ - 8½ inches, which is greater than the 5½ - 6½ inches in the directed cod fisheries of 1998-2002.

Reported landings during 2004 were approximately 520 t of by-catch from commercial fisheries and 120 t from the sentinel surveys, for a total of 640 t. Landings from all sources are presented by gear, unit area and month in Table 4b. Gillnets contributed 96% by weight, small mesh gillnets from sentinel surveys 1%, linetrawls 1% and handlines << 1%.

Almost all of the by-catch came from the winter (blackback) flounder fishery.

By-catch from Canadian trawlers fishing offshore was 6 t.

An estimate is not yet available for the 2004 catch by non-Canadian trawlers outside the 200 nautical mile limit on the Nose of the Bank (Div. 3L). The Scientific Council of the Northwest Atlantic Fisheries Organization (NAFO) determined that catches during 2000-2003 were 20-80 t annually (Table 1).

2.4 By-catch, discards and illegal fisheries

By-catches of cod occur in ongoing Canadian and non-Canadian fisheries. All recorded by-catch has been incorporated into the catch (Tables 1,2), but not all by-catch is recorded.

In the inshore, by-catches are common in gillnet fisheries for lumpfish and especially winter (blackback) flounder. They also occur in the herring gillnet fishery and the capelin trap fishery. Note that for winter flounder and herring there are both commercial fisheries and bait fisheries. The only inshore fishery that has been studied specifically for by-catch is the herring gillnet bait fishery, in which by-catches of cod appear to be small (Reddin et al. 2002).

In the offshore, by-catches of cod by Canadian fleets have, in recent years, come from trawl fisheries for yellowtail flounder and both trawl and gillnet fisheries for Greenland halibut. The recorded by-catches in these fisheries have been small.

A catch of cod by non-Canadian fleets has been reported for the area outside the 200 mile limit on the Nose of Grand Bank in Division 3L. These catches are understood to be small (20-80 t annually in 2000-2003).

Discards

The discarding of cod in the shrimp fishery was dramatically reduced with the introduction of the Nordmore grate in 1993 (Kulka 1998). Total discards from the large-vessel shrimp fishery in 2J3K were 5 t in 1995 and 13 t in 1996 (Kulka 1998).

Shrimp quotas increased dramatically during the late 1990s, and a new fleet of smaller trawlers entered the fishery in 1997. The level of observer coverage in this fleet of smaller vessels has been low (Orr et al. 2002). Therefore, the total quantity of discards may have increased since the mid-1990s, and the opportunities for observing such discards have declined.

Shrimp fisheries expanded into Div. 3L during the 1990s and increased considerably starting in 2000. Studies during the early years of these fisheries indicated that there was little overlap between the distributions of shrimp and small cod during the autumns of 1995-1998 (Orr et al. 1999), and the discards of cod by small and large shrimp vessels combined was less than 1 t annually during 2000 and 2001 (Orr et al. 2002).

D. Orr (Fisheries and Oceans Canada, St. John's, NL, October 2004, pers. comm.) provided estimates of the quantity of cod discarded by large and small shrimp vessels in 2J3K and 3L for the years 1997-2003 (Lilly and Murphy 2004). The procedure used was similar to that described for the estimation of by-catch of Greenland halibut in the same fisheries (Bowering and Orr 2004). It was estimated that discards in 2J, 3K and 3L combined by both fleets combined were less than 5 t each year.

Additional unquantified sources of mortality include the fallout and discarding of low quality cod caught in gillnets, and the discarding of small cod caught by handlining.

Illegal fishing

It is known that in recent years there have been removals in inshore waters in excess of sentinel surveys and legal fisheries. The magnitude of poaching is not known.

The impact of unaccounted fishing mortality

In the offshore, cod appear to experience an extraordinarily high mortality rate (see Section 7.1.3). The extent to which this is attributable to mortality associated with unreported catch, discards and injury caused by contact with gear (e.g. shrimp trawls) is not known. However, any such deaths may be important because the abundance of cod in the offshore is so very low.

In the inshore, the magnitude of unreported by-catch and poaching is not known, so the impact of such removals cannot be assessed.

2.5 Sampling of catch in 2003 and 2004

The sentinel survey was sampled intensively in both 2003 and 2004. Sampling of by-catches from other fisheries was insufficient is some cases and had to be augmented by sentinel survey data. Sampling of by-catch is difficult because landings tend to be small at any specific time and place, and it is difficult to predict when landings will occur.

The number of fish measured in 2003 and 2004 is given by gear, unit area and month in Tables 5a and 5b respectively. The number of fish aged in 2003 and 2004 is given by gear, unit area and quarter in Tables 6a and 6b respectively.

2.6 Catch numbers and weights at age

The age composition and mean length-at-age of the landings were initially calculated by gear, unit area and quarter as described in Gavaris and Gavaris (1983). The following relationship was applied in deriving average weight-at-age:

$$\log(\text{weight}) = 3.0879*\log(\text{length}) - 5.2106.$$

Landings during 2003

The catch at age in 2003 was reported by Lilly et al. (2004), and is reproduced *verbatim.*

In terms of numbers of fish, the landings in 2003 were dominated by the mass mortality in Smith Sound (68%), followed by gillnets of mesh size 5½ inches or greater (28%), and small mesh gillnets (3¼ inches) from the sentinel survey (4%) (Table 3).

The total catch-at-age in 2003 comprised a range of ages, with ages 3 to 14 each contributing at least 2% by number and age 6 most prominent. The age composition does not represent a regular progression from the age compositions seen over the previous 5 years (see Fig. 7c of Lilly et al. 2003). Specifically, older ages (11-14) are much more strongly represented than would be expected. This is a result of the small contribution of gillnet (5½ – 6½ inch mesh) and hook and line gears to the total landings. Instead, the landings were dominated by the fish from the Smith Sound mass mortality. Sampling associated with hydroacoustic studies in Smith Sound has shown that the cod that occur in the dense overwintering aggregations within the sound are primarily of ages 3-4 and older, and that the 1990 and 1992 year-classes are well represented (Rose 2003). The sampling of fish taken to fish plants during the 2003 mass mortality shows the 1990 and 1992 year-classes to be very well represented, and the 1991 year-class to be stronger relative to the 1990 and 1992 year-classes than it appears in sampling associated with the acoustic surveys (Rose 2003).

Landings from gillnets (5½ inches and greater) were dominated by cod of ages 6 and 7 and landings from sentinel small mesh gillnets were dominated by ages 3 and 4. This corresponds to observations in many previous years (see Figs. 7a,b and 20 of Lilly et al. 2003).

Landings during 2004

In terms of numbers of fish, the landings in 2004 were dominated by gillnets (95%) (Table 7a). Linetrawl accounted for 2%.

The total catch-at-age in 2004 comprised a range of ages, with ages 3-10 and 12 each contributing at least 2% by number and age 7 most prominent (Table 7a; Fig. 7a). The ages caught in gillnets were, of course, almost identical to those in the total catch. Landings from linetrawls were mainly of ages 3-6 with age 4 most prominent.

As discussed in Section 7.2.2.2, a sequential population analysis was conducted based on fish caught in the central portion of the inshore. This area accounted for 67% of the fish landed (Table 7b; Fig. 7b). The age composition from the central area was similar to that from the total stock area (see above). Landings from the southern inshore area were less broadly distributed across ages than the landings from the central area, and were more strongly dominated by age 7 (the 1987 year-class).

Historic pattern

The catch-at-age of fish in the reported landings (inshore and offshore) from 1962 to 2004 is presented in Table 8. The 1989 year-class was the most important contributor to the catch in 1993-1994. The 1990 year-class was the most important contributor in 1995-1997, the 1992 year-class in 1998-1999, the 1994 year-class in 2000, and the 1987 year-class in 2001-2004. The fact that a more recent year-class has not become prominent in the catch of the past two years may be related to the extremely low proportion of catch coming from gears (notably handline, but also linetrawl) that tend to catch smaller fish.

The age compositions of the total landings from 1998 to 2004 illustrate the broadening of the age composition of the populations currently inshore. As described in earlier reports, there had been a severe truncation of the age composition by the mid-1990s (see Table 8). When the index fishery opened in 1998, there were very few fish older than age 9 (the 1989 year-class) (Fig. 8). However, the 1990 and 1992 year-classes were moderately strong in the inshore and have persisted, so that by 2002 there was good representation to age 12, and there were even some age 13s. The age composition from the Smith Sound mass mortality in 2003 may be interpreted as indicating that the older (1990-1992) year-classes are even better represented in the Smith Sound overwintering aggegation than in the 2002 catch for 2J3KL as a whole. This interpretation must be treated with caution, however, because it is possible that older cod experienced higher mortality than younger cod during the Smith Sound event. At present there is insufficient additional data to inform this issue. The age composition of the 2004 catch is similar to that which would be expected as a progression from the 2002 catch. The 1990 and 1992 year-classes are persisting at ages 14 and 12, but they are weakly represented.

The mean weights-at-age calculated from mean lengths-at-age in the landings have varied over time (Table 9; Fig. 9). There was an increase in the late 1970s and early 1980s, followed by a decline through the 1980s to low levels in the early 1990s. There has been substantial improvement in the latter half of the 1990s, and for some age-groups (e.g. ages 4-7) the weights-at-age calculated for recent years were at or near the highest levels in the time-series. Interpretation of changes in the weights-at-age is difficult because of changes in the relative contributions of the various gear components and changes in the location and timing of catches from each gear component. For example, much of the landings prior to the moratorium came from otter trawling offshore early in the year, whereas since the moratorium most of the catch has come from fixed gear inshore in the second half of the year. In addition, the high proportion of landings coming from gillnets in recent years will tend to increase the calculated mean weight-at-age of those age-classes entering the selection range of the gear. This may apply in particular to ages 5 and 6. There may also be an underestimate of weight-at-age for those age-classes leaving the selection range of gillnets.

There are clearly problems with the 1993 weights-at-age that remain to be resolved.

The biomass at age in the reported landings from 1962 to 2004 is presented in Table 10.

3 Stakeholder perspectives

A telephone survey was conducted by the Fish, Food and Allied Workers (FFAW) Union to assess the opinions of fish harvesters regarding the abundance of cod in inshore waters, the size and condition of the cod, and the abundance of prey (Jarvis and Stead 2005). In 2J, most fish harvesters felt that cod abundance during 2004 was lower than it had been during the late 1980s but higher than it was during 2002, the last year of the commercial index cod fishery. In 3K, there was no clear indication of how cod abundance in 2004 compared with abundance during the late 1980s, but most harvesters felt that abundance in 2004 was about the same or better than it had been during 2002. In 3L, most harvesters in Bonavista, Trinity and St. Mary's bays felt that cod abundance during 2004 was better than it had been in the late 1980s and better than during 2002. In Conception Bay and along the eastern Avalon Peninsula, there was no clear indication of how abundance in 2004 compared with abundance during the late 1980s, but most harvesters felt that abundance during 2004 was better than it had been during 2002.

4 Stock structure

The first item in the remit for the present assessment was as follows:

"Review the evidence regarding whether populations of cod currently inhabiting inshore waters are self-sustaining and distinct from populations that historically overwintered and spawned in the offshore and migrated seasonally to the inshore."

The only new data or analyses presented to the meeting was the information from the Smith Sound mass mortality (see below). However, evidence presented during previous stock assessment meetings was reviewed. Much of this information has recently been summarized by Lilly and Murphy (2004), and the following text and additional details (Appendix 4) are taken largely from that source.

Numerous studies have indicated the likelihood of substock structure within the northern cod stock complex (see, for example, overviews by Lear 1986; deYoung and Rose 1993; Smedbol and Wroblewski 2002). The evidence includes a north-south cline in size-at-age and time of spawning, and a change in vertebral counts at approximately the north slope of Grand Bank. Cod tagged at specific locations in the offshore in winter tended to migrate to specific but broad areas of the inshore during summer and then returned to approximately the area of tagging in subsequent winters. It was also known that cod overwintered in various locations inshore and that some spawning occurred inshore.

Since the mid-1990s, there has been a dichotomy between the offshore and the inshore. In the offshore, research bottom-trawl surveys have found cod to be at very low density. The fish are small and young, especially in Div. 2J and 3K. In contrast, aggregations sampled inshore since the mid-1990s by commercial fisheries, sentinel surveys, and research bottom-trawling within Smith Sound in winter contain a high proportion of individuals that are older and larger than those taken by the offshore surveys. A larger run of fish has also been evident in the winter cod-seal events and the mass mortality of cod in Smith Sound in April 2003 (Lilly et al. 2004).

Tagging studies conducted subsequent to the collapse indicate that the inshore of 3KL is currently inhabited by at least two groups of cod: (1) a northern resident coastal group that inhabits an area from western Trinity Bay northward to western Notre Dame Bay and (2) a migrant group that overwinters in inshore and offshore areas of 3Ps, moves into 3L during late spring and summer, and returns to 3Ps during the autumn. Tagging studies also indicate considerable movement of cod among Trinity, Bonavista and Notre Dame bays. This stock structure was not evident historically because the majority of fish observed during inshore fisheries were migrants from the offshore.

Additional support for the existence of a resident coastal group comes from examination of the tagging information associated with the mass mortality event in Smith Sound (Fig. 1g) during April 2003 (Brattey and Healey 2005). Most of the 418 tags recovered during the event had been applied in the local area encompassing Smith Sound itself, the waters around Cape Bonavista and southern Bonavista Bay. No tags had been applied in 3Ps or 3Pn4RS, despite intensive tagging programmes in both of those stock areas. Only one tag had been applied in 3K, and only one tag had been applied in southern 3L (Conception Bay and southward). This is consistent with previous conclusions that Smith Sound is an overwintering area for a group of cod that during late spring and summer moves northward along the north side of Trinity Bay and may round Cape Bonavista, with some individuals moving into southern 3K. The absence of fish that had been tagged in 3Ps, and the recapture of only one fish that had been tagged in southern 3L, indicates that the cod that move from 3Ps into 3L in summer return to 3Ps in winter.

It is not known if there is currently movement of adult cod between the inshore and the offshore of 2J3KL. There has been only one reported offshore recapture of a cod tagged inshore after the mid-1990s, but of course there has been no directed offshore cod fishery during this period, so recaptures could come only from fisheries directed at other species. It is thought that migrants from offshore 2J3KL currently contribute little to the biomass of cod in the inshore of 2J3KL.

Several additional sources of information are consistent with the hypothesis that there are distinct inshore or bay stocks along the east coast of Newfoundland. The information includes the presence of cod inshore in the winter, the historic existence of spring fisheries in the inner reaches of Bonavista and Trinity bays before cod arrived at the headlands from the offshore, and the occurrence of spawning within the bays. See Appendix 4 for additional details regarding the biology and distinctiveness of cod in the inshore.

Genetic studies suggest that the northern cod conforms to an isolation-by-distance structure, with cod from more distant locations tending to be more distinct (Beacham et al. 2002). There appear to be differences between the inshore and the offshore, and among various areas of the offshore (Ruzzante et al. 1998; Beacham et al. 2002; but see Carr et al. 1995). Subpopulation structure at the level of individual bays is less strongly supported.

In summary, various observations, both historic and recent, are consistent with the hypothesis that there are populations in the inshore that are functionally distinct from those in the offshore. It is thought that these inshore populations have historically been small relative to the populations that migrated into the inshore from the offshore during spring/summer.

5 Population indices

5.1 Bottom-trawl surveys

5.1.1 Survey design

Research vessel surveys have been conducted by Canada during the autumn in Divisions 2J, 3K and 3L since 1977, 1978 and 1981 respectively. No autumn survey was conducted in Division 3L in 1984, but the results of a summer (August-September) survey in 1984 have been used for some analyses. The 1995, 2002, 2003 and 2004 autumn surveys continued into late January of the following years. Spring surveys have been conducted by Canada in Division 3L during the years 1971-1982 and 1985-present.

The autumn surveys in Divisions 2J and 3K were conducted by RV *Gadus Atlantica* until 1994. In 1995-2000 they were conducted mainly by RV *Teleost*, although RV *Wilfred Templeman* surveyed part of Division 3K. Surveys in Division 3L were conducted by RV *A.T. Cameron* (1971-1982) and RV *Wilfred Templeman* or its sister ship RV *Alfred Needler* (1985-2000 for spring and 1983-2000 for autumn). In recent years, RV *Teleost* occupied some of the 3L stations, particularly those in deep water. The surveying in Divisions 2J and 3K became increasingly complex in 2001-2004, with more individual trips required to complete the surveys and increased incidence of more than one ship contributing to the surveying of each Division.

During the autumn of 1995 both ships used for the first time the Campelen 1800 shrimp trawl with rockhopper footgear, replacing the Engel 145 Hi-rise trawl that had been used since the start of the surveys in 2J and 3K and since the change to the RV *Wilfred Templeman* in Division 3L. In addition, the Campelen trawl was towed at 3.0 knots for 15 min instead of 3.5 knots for 30 min. The selectivities of the two nets were found through comparative fishing experiments in 1995 and 1996 to be markedly different, with the Campelen being far more effective at catching small cod (Warren 1997; Warren et al. 1997). There were limited data for the comparison of larger cod. Conversion of Engel catches to Campelen equivalent catches was reported by Stansbury (1996, 1997).

The survey stratification scheme, illustrated in Fig. 10-12, is based on depth intervals intersected by lines of latitude and longitude (Doubleday 1981; Bishop 1994). The strata used in 1996 were similar to those in previous years except that the survey was extended to 1500 m and 25 new strata were added to the inshore in Divisions 3K and 3L to obtain an estimate of the cod landward of the standard survey area. The survey in 1997 was similar to that in 1996, except that some of the new inshore strata were modified and one stratum was added. The survey in 1998 was as in 1997. The survey in 1999 was as in 1997 and 1998 except that the new inshore strata were not fished. The surveys in 2000-2004 were similar to those in 1997-1998.

Prior to 1988, set allocation was proportional to stratum area, with the provision that each stratum be allocated at least 2 sets. In 1989 and 1990 an "adaptive design" was introduced in an attempt to minimize variance. It was found that this method introduced a bias and the additional sets fished during the second phase of these surveys have been excluded from analyses. In 1991-1994, additional sets were allocated in advance to certain strata based on past observed stratum variance (Gagnon 1991). In 1995-2004, set allocation was based once again on stratum area alone (with the provision that there be at least 2 sets in each stratum).

Additional details on the surveys conducted since the introduction of the Campelen trawl in 1995 are provided by Brodie (2005).

Incomplete coverage during the autumn 2004 survey

During the 2004 autumn survey in 2J3KL, several strata in Div. 3L were not fished. These included 7 strata that would normally be included within the offshore index (<= 200 f) (strata

365, 366, 368-370, 386, 387), 1 stratum in the 201-300 fath range (stratum 735), 2 strata within the 301-400 fath range (strata 734, 736), and all strata deeper than 400 fath (Fig. 13). The strata deeper than 400 fath did not yield any cod in any of the years when they were fished (1996-2003). However, the shallower strata certainly did contain cod in at least some of the years since the introduction of the Campelen trawl in 1995.

The number and weight of cod that might have been in the missed strata at the time of the survey have not been estimated. See Section 5.1.2.3 for a brief discussion.

5.1.2 Autumn bottom-trawl surveys

5.1.2.1 Autumn abundance and biomass

Abundance and biomass have been estimated by areal expansion of the stratified arithmetic mean catch per tow (Smith and Somerton 1981). To account for incomplete coverage of some strata in some years, estimates of biomass and abundance for non-sampled strata were obtained using a multiplicative model.

Estimates of abundance and biomass from the autumn surveys in 1978-1994 (Divisions 2J and 3K) and 1981-1994 (Division 3L) may be found in Tables 12-19 of Shelton et al. (1996). The data from 1983 to 1994 have been converted to Campelen equivalents and are presented in this paper along with the actual Campelen data from 1995-2004. Data for Division 2J are in Tables 11-14 and data for Division 3K are in Tables 15-18. Note that data for 1993-2004 are presented separately from earlier years for Divisions 2J and 3K because of the change in stratification scheme introduced in 1993 (Bishop 1994). Estimates for surveys in Division 3L are in Tables 19-20 for strata in depths <= 200 fathoms (366 m) and Tables 21-22 for strata in depths > 200 fathoms.

Because there have been changes over time in the depths fished, annual variability in the abundance and biomass of cod has been monitored for those strata that have been fished most consistently since the start of the surveys. These "index" strata are those in the depth range 100-500 m in Divisions 2J and 3K and 55-366 m (30-200 fathoms) in Division 3L. The inshore strata fished in 1996-1998 and 2000-2004 are not included in the index. Because an index has also been calculated for the inshore strata, the former "index" will be referred to in this paper as the "offshore index".

Changes in abundance and biomass in the offshore index strata are shown by Division for the years 1983-2004 in Fig. 14. The patterns in abundance and biomass differ in detail, reflecting changes in the relative abundance of small and large fish. Of note are the strong positive anomaly in 2J and 3K in 1986, the very large increase in 3K in 1989 and the rapid decline during the early 1990s. Abundance and biomass have remained at extremely low levels in all Divisions since 1993.

Abundance and biomass estimates for the new inshore strata that were fished in 1996-1998 and 2000-2004 are provided in Tables 23 and 24.

The total abundance and biomass of all strata fished in 1983-2004 are provided by Division and year in Table 25.

The abundance and biomass for offshore index strata, deep offshore strata and inshore strata are provided in Table 26 by Division and year for the 10 years since introduction of the Campelen trawl. The highest abundance and biomass has generally been found in the offshore index strata. The quantities found in the offshore deep strata have been highly variable, and always less than in the offshore index strata. The quantities found in the inshore strata have also been highly variable. During 1996 and 2003, the abundance in the inshore strata of Division 3L exceeded the abundance found in the offshore index strata.

Abundance in offshore index strata declined from 1995 to 1997, increased from 1998 to 1999, and then fluctuated without trend (Table 26; Fig. 14). Biomass in offshore index strata increased from 1995 to 1997-1998, nearly doubled in 1999, remained relatively constant in 2000-2001, and then fluctuated at a lower level. The average biomass in offshore index strata during 2002-2004 was about 18,500 t, which is about 1.5% of the average biomass of about 1,200,000 t (in Campelen equivalents) in the period 1983-1988 (excluding the high value in 1986).

It is not known if the continuation of the surveys into January has created a bias in estimation of abundance and biomass. However, the continuation of the surveys into January does have an effect on the perceived depth distribution of fish. The estimates of the number and biomass of cod in depths greater than 500 m were greater when the surveys were extended beyond the end of the year, *viz* in 1995 and 2002 in Division 2J and in 1995, 2002, 2003 and 2004 in Division 3K (Fig. 15).

5.1.2.2 Autumn mean catch at age per tow

5.1.2.2.1 Offshore index strata

The divisional mean number caught at age per tow in offshore index strata during autumn surveys from 1979 (1981 in Division 3L) to 1994, and the mean number per tow for Divisions 2J, 3K and 3L combined, may be found in Tables 3-6 of Bishop et al. (1995b). The data from 1983 to 1994 have been converted to Campelen equivalents and are presented along with the actual Campelen data from 1995-2004 in Table 27 for Divisions 2J, 3K and 3L separately and for all three Divisions combined. Mean catch per tow has continued to be very low for each age in each Division during the past few years when compared with many years in the 1980s and early 1990s.

The matrix of mean number caught at age per tow for all divisions combined is used to provide information on spawner biomass, recruitment and mortality in the offshore (Section 7.1).

5.1.2.2.2 Inshore strata

Inshore strata in 3K and 3L were fished in 1996-1998 and 2000-2004. The mean catch at age per tow was calculated for 3K and 3L separately and for 3KL combined (Table 28). Each 3KL value is the mean of the divisional means, weighted by the divisional survey areas (where the area of inshore strata is 3,235 sq n miles in 3K and 3,107 sq n miles in 3L).

5.1.2.3 Effect of strata missed during autumn 2004

As described above and in Brodie (2005), several strata in eastern Div. 3L were not surveyed during the autumn 2004 survey. Seven of these strata are in depths less than 200 fathoms (366 m) and are considered part of the offshore index area.

The number of fish that may have been missed was evaluated by a simple examination of the results of the previous nine surveys conducted with the Campelen trawl (1995-2003). (Note that all these surveys have occurred since the collapse of the stock.) The number of fish computed to be within the seven strata missed during 2004 was expressed as a percentage of the number of fish computed to be within all index strata in Div. 3L. This percentage varied from 9% to 37% (median = 15%). Percentages in the most recent two years (2002 and 2003) were 35% and 12% respectively.

Two approaches to estimating the abundance/biomass of cod that might have been in the missed strata were considered.

One method is to use the by-stratum pattern in population distribution from previous years, together with the abundance in those strata fished during 2004, to estimate the abundance of cod in those strata that were missed during 2004. This approach (a multiplicative model) had been employed in the past. However, an examination of the tables of estimated abundance/biomass by stratum and year, plus an inspection of distribution plots, indicated that the magnitude of catches within individual strata varied considerably among years. It was decided that there was too much year-to-year variability to fill each missed stratum from a multiplicative model.

A similar approach would be to estimate the abundance of cod in the missed strata by assuming that the abundance in those strata combined was more stable across years than the abundance in individual strata, and by comparing the historic (1995-2003) abundance in the missed strata with the comparable abundance in strata that had not been missed. One possibility for this approach would be to compare the abundance in the missed strata with the abundance in all other 3L strata. However, it was thought that the abundance of cod in the northeastern portion of Div. 3L might vary somewhat independently of the abundance of cod on the plateau of Grand Bank, which might be influenced by fish crossing the 3NO boundary, and might also vary independently of the abundance of cod in the Avalon Channel, which might be influenced by cod migrating from Subdiv. 3Ps. It was decided to look at the abundance of cod in the missed strata in relation to the abundance of cod in adjacent strata (viz. 346-348, 364, 371, 385, 388, 389, 733, 638, 650-652). (This includes 4 strata in Div. 3K.)

For the 9 years since the introduction of the Campelen trawl (1995-2003), the number of cod estimated to be in those strata that were missed in 2004, expressed as a proportion of the number in those strata plus the adjacent strata (as defined above), varied from 0.16 to 0.51 (median = 0.24). It was concluded that there was insufficient consistency to justify increasing the 2004 catch by some specific proportion.

It was therefore decided that population estimates would be reported for those strata that were fished during the 2004 survey, without any adjustment. It was also decided that the estimates of stratified arithmetic mean catch at age per tow would be reported for only those strata that were fished.

5.1.2.4 Autumn distribution

The distribution of cod at the time of the autumn surveys has been illustrated in numbers per standard tow (Shelton et al. 1996; Murphy et al. 1997) and in weight (kg) per standard tow (Lilly 1994, 1995). The catch from each tow in the period 1983-1994 has been recalculated to Campelen equivalents, and plots of these recalculated catches for 1985-1994 are illustrated in Lilly et al. (1999).

For the period 1980-1988, catches were widespread over the survey area, with larger catches tending to occur in four loosely defined areas: (1) from the northern limit of the survey to the coastal shelf off northern Newfoundland, especially the northern tip of Hamilton Bank and near the isthmus leading to Belle Isle Bank; (2) the outer trough between Belle Isle Bank and Funk Island Bank; (3) the outer trough between Funk Island Bank and Grand Bank, and from there southeastward along the northeastern slope of Grand Bank; and (4) the plateau of Grand Bank (Fig. 16). The first indication of the big changes to come occurred in 1988, when almost no fish were caught in the area of Harrison Bank in northwestern Division 2J (Lilly et al. 1999). Commencing in 1989 the fish in Divisions 2J and 3K became increasingly concentrated toward the edge of the bank. By 1991, concentrations on Hamilton Bank and the plateau of Grand Bank disappeared, leaving fish in inner Hawke Saddle and in the saddles between Belle Isle Bank and Funk Island Bank and between Funk Island Bank and Grand Bank. In 1992, only the concentration between Funk Island Bank and Grand Bank remained. This concentration was smaller in 1993 and disappeared in 1994.

Catches from 1995 onward (Fig. 17) tended to be very small. (See Fig. 16 for a comparison between the average catches in 1980-1988 and the catches taken during 2002.). On the southern Labrador Shelf and the Northeast Newfoundland Shelf (Div. 2J,3K) the larger catches were broadly spread, with a tendency toward occurrence off the banks. The area with the most consistent relatively large catches has been around Funk Island Bank, particularly to the east and southeast.

As noted above, the 1995 and 2002-2004 surveys were not completed during the calendar year, and some of the strata were fished early in the following year. Each of these four surveys is again illustrated in Fig. 18, where the sets before and after the end of the calendar year are displayed separately. As noted by Lilly et al. (2004), the degree of aggregation on the outer flanks of the banks may appear higher in years when these areas are surveyed after the end of the calendar year. This is not surprising in an historic context. Prior to the collapse of the stock, there were large winter (January-April) fisheries on overwintering aggregations along the shelf break. The extent to which the surveying after January 1 may create a bias in the population estimates remains unknown at this time.

5.1.3 Spring 3L bottom-trawl surveys

5.1.3.1 Spring 3L abundance and biomass

Abundance and biomass of cod in Division 3L in the spring have been estimated by areal expansion of the stratified arithmetic mean catch per tow. Estimates for the surveys from 1978 to 1995 may be found in Tables 20-21 of Shelton et al. (1996). The data from 1985 to 1995 have been converted to Campelen equivalents. Estimates of abundance and biomass for the index strata (depths <= 366 m or 200 fathoms) during 1985-2004 are provided in Tables 29 and 30 respectively and illustrated in Fig. 19. The indices declined very rapidly from 1990 to 1993. However, there was a considerable quantity of fish in deeper strata during 1992 (see below). There are indications from other sources that the cod were distributed more deeply during the early 1990s than they had been during the 1980s, so the rapid decline in the spring indices during the early 1990s may reflect in part a movement to depths beyond the index strata.

The indices have remained very low since the mid-1990s (Fig. 19). The biomass index during 2002-2004 was less than 1% of the average in the period 1986-1989.

Surveying in waters deeper than 200 fathoms started on a regular basis in 1991 (Table 31). In some years, most notably 1992, a substantial biomass was estimated to lie in these deeper strata. There may have been a large biomass in the deeper water in 1991 as well. Stratum 735 (201-300 fath), which was estimated to contain 50,000 t in 1992, was not fished in 1991 because of ice cover. The percentage of the total estimated biomass found in depths greater than 200 f has been as high as 92% in 1994 and as low as 2% in 1999. The values in 2001 - 2003 were 43% , 49% and 65%, respectively. There were no cod caught in these deeper strata in 2004.

5.1.3.2 Spring 3L mean catch at age per tow

The mean numbers caught at age per tow in index strata during 3L spring surveys from 1985 to 2004 are presented in Table 32. The values from 1985 to 1995 are Campelen equivalents and those from 1996 onward are based on actual Campelen catches. Mean catch per tow declined precipitously in the early 1990s and values continue to be well below levels obtained prior to 1993.

5.1.3.3 Spring 3L distribution

The distribution of cod during spring surveys in Division 3L is shown together with distribution in Divisions 3NO for the years 1984-2000 in Figs. 18-20 of Lilly et al. (2001). During the second half of the 1980s the spring distribution in Division 3L was similar to that observed during the autumn, in that the highest densities were generally on the plateau of the bank and along the northern and northeastern slopes of the bank. However, in some years there were also moderately large catches in the area between the northern slope and the plateau, a situation much less evident in the autumn. The spring of 1990 was unusual, in that few cod were taken on the plateau but very large catches were taken along the full length of the northeastern slope. Much of the northeastern slope could not be surveyed in 1991 because of ice cover, but catches seemed to be smaller. Catches continued to decline until 1995 when very few cod were caught.

Catch rates increased with the introduction of the Campelen trawl in 1996 (Fig. 20a), but have remained far below the levels of the 1980s. Starting in 1996 the cod in 3NO appeared to be further onto the bank at the time of the surveys than they were in the early 1990s. In 1999 there was a hint, for the first time in many years, of a continuous distribution of cod from the southwestern part of 3O across the 3L/3NO boundary into the area of the Virgin Rocks. In 2000 cod were caught around the periphery of the bank, from the southernmost part of the Northeast Newfoundland Shelf in northern 3L, along the northeastern slope of Grand Bank to the Nose of the Bank, and southward to the 3L/3NO boundary. Small catches were also taken on the plateau of the bank and in the Avalon Channel. In 2001, 2002 and 2003, the distribution was similar to that in 2000, except that there appeared to be fewer cod on the plateau of Grand Bank and in the Avalon Channel (Fig. 20b). In 2004 there were very few cod caught along the northeastern and eastern slopes (Fig. 21). No cod were caught in depths greater than 200 fathoms (366 m).

5.2 Sentinel surveys

Sentinel surveys for cod were conducted by fishing enterprises operating from many communities (Fig. 1f) in Divisions 2J, 3K and 3L at various times during summer and autumn 1995-2004. The number of enterprises varied between 53 and 59 during 1995-2002, but was reduced to 44 in 2003 and 45 in 2004. Since 1999 sampling has been conducted for a minimum of 10 weeks at each site.

The primary goal of these surveys when they were initiated was to obtain information on catch rates on traditional inshore fishing grounds during the moratorium. The surveys continued during the period of index/commercial fishing (1998-2002). The surveys have been conducted primarily with gillnets (5½ inch mesh). Linetrawls have been used extensively in only a few areas, and indeed the use of linetrawls has declined over time. Handlines and cod traps have been used much less. Small mesh (3¼ inch) gillnets were introduced at many sites in 1996 to provide information on the relative size of incoming year-classes.

The sentinel surveys were also intended to provide samples that would yield information on various aspects of the biology of cod in the inshore, including age compositions, size-at-age, condition, maturity and feeding. Various analyses were conducted on data collected in 1995-1997 (Lilly 1997; Lilly et al. 1998a), but these have not been updated. However, age compositions for the full time period are now available in the form of standardized catch rates at age (see Section 5.2.2).

Note that sampling for lengths and ages has been relatively intensive in the sentinel surveys. Without this sampling, it would have been very difficult to decompose the catch from the index/commercial fisheries into catch at age, particularly in 2002.

5.2.1 Sentinel catch rates by site and Division

Maddock Parsons et al. (2000) provided weekly average catch rates by sentinel survey site, gear and year (1995-1999). There is considerable among-site variability in the timing of fishing effort and in the seasonal and annual patterns in fishing success. Catch rates have been relatively low since the start of the survey in 2J and in 3K north of White Bay.

Maddock Parsons and Stead (2005) presented weekly average catch rates and annual relative length frequencies (number of fish at length divided by amount of gear) by gear, NAFO division, and year (1995-2004).

The 5½ inch gillnet has the narrowest range of selectivity (50-80 cm). Catch rates have been lowest in 2J and highest in 3L. In all Divisions, catch rates declined from 1998 to 2002 and then increased in 2003 and 2004.

Catches in the small mesh (3¼ inch) gillnet are characterized by two modes; the smaller (approximately 34-44 cm) is represented by fish that are meshed in the net and the larger by fish that are entangled in the net. Catches in this gear tend to be variable over time and space. In 2J the smaller mode declined from 1997 to 1999 and has been variable since then. In 3K the smaller mode declined from 1996 to 1999 and remained at the lower level except in 2003, when there was an increase. In 3L the smaller mode was relatively stable over time, except for a decline in 1999 and an increase in 2003. The catches of the larger fish declined from 1998 to 2001 in all divisions, and increased in 2003 and 2004.

Linetrawl has the widest range of fish sizes. In 2J, catch rates were lower than in 3K and 3L. Linetrawl has not been deployed in 2J since 2001. In 3K, catch rates declined from 1997 to 2000 and then increased to 2004.

5.2.2 Sentinel standardized (modelled) CPUE

An age-disaggregated index of standardized relative abundance for cod in the inshore of 2J3KL was calculated from data gathered from sentinel fishing with gillnets and linetrawls (Stansbury et al. 2000). The catch from 2J3KL was divided into cells defined by gear type (gillnet 5½ inch, gillnet 3¼ inch and linetrawl), NAFO Division (2J, 3K, 3L), statistical unit area (e.g. 3Ki, 3Lh), year (1995-2004) and quarter. Age-length keys were generated for each cell using fish sampled from both fixed and experimental sites. There were no fixed sites using 3¼ inch gillnets. Length frequencies and age-length keys are combined within cells. Numbers of fish at length were assigned ages using an age-length key. Because there were few or no discards in the sentinel fishery and the fish harvesters measured the length of all the fish caught with linetrawl and gillnet, obtaining catch numbers-at-age was relatively straight forward [see Stansbury et al. (2000) for details].

Methods

The catch per unit effort (CPUE) at age data were standardised to remove site and seasonal effects. For gillnets, only sets fished during July to November with a soak time between 12 and 32 hours were included in the analysis. (Note that Lilly et al. (2003) stated that only sets with soak times between 18 and 24 hours were included in the analysis. This is an error. The 2003 analysis incorporated sets with soak times between 12 and 32 hours.) For linetrawl, sets fished during August to November with a soak time less than or equal to 12 hours were selected. Sets with effort and no catch for some or all ages were considered valid entries in the model. Ages in the model ranged from 3 to 10 for 5½ inch gillnet, 2 to 10 for 3¼ inch gillnet and 3 to 9 for linetrawl. Fish older than age 10 were not included because of their rarity.

A generalized linear model (McCullagh and Nelder 1989) was applied to the catch and effort data for each gear and survey method. The response distribution was specified as Poisson and the link function was chosen to be log. That is, the Poisson mean parameter μ_i is related to the linear predictor by

$$\log(\mu_i) = \mathrm{X}_i'\beta$$

where X_i is a vector of explanatory factors for catch observation i (i.e. month, site, age and year) and β is a vector of coefficients to be estimated from the data.

Thus catch is assumed to have a Poisson probability distribution with the mean μ_i related to the factors month nested within site and age nested within year by

$$\log(\mu_{jklm}) = \log(E_{jklm}) + \beta_{jk}(month_j \times site_k) + \beta_{lm}(age_l \times year_m)$$

where E is an offset parameter for fishing effort and the subscripts j,k,l,m indicate the level for month, site, age and year, repectively. For example, for the factor *month*

$$month_j = \begin{cases} 1 \text{ if month} = j \\ 0 \text{ if month} \neq j \end{cases}.$$

The levels for *month*, *site* and *age* vary across gear type.

Site/month combinations in which fewer than 5 fish were landed in all years combined were deleted from the analysis because of difficulties with estimation. (This differs from the analysis in 2003, when site/month combinations in which no fish were landed in all years were deleted from the analysis.)

The model was fit using the SAS procedure GENMOD. Amount of gear is expressed as number of nets for gillnet and number of hooks for line trawl. Estimates for age nested in year were adjusted for month nested in site effects (i.e. least-squares means) and transformed to a linear scale to give the relative index at age for each year.

Additional details regarding the models (proportion of available data that was actually included, model output and residual plots) were reviewed but are not provided in the present paper. Such information from an earlier analysis of the 1995-1999 data are described in detail by Stansbury et al. (2000).

Age-aggregated indices were computed by summing the age within year effects for each year.

Catch rates from the whole of the inshore

The standardized catch rates from the 5½ inch gillnets (Fig. 22) increased from 1995 to 1998, declined to 2002 and increased in more recent years so that the level in 2004 was similar to that during 1995, the year that the surveys started. Linetrawl catch rates (Fig. 22) showed relatively little change from 1995 to 1996, increased in 1997, declined to a low in 2000, and then increased irregularly so that the level in 2004 was similar to that in 1995. It is emphasized that the linetrawl catch rates are based on relatively small sample sizes.

The standardized catch rates at age from the 5½ inch gillnets (Fig. 23) illustrate that the 1990 and 1992 year-classes were relatively strong. Subsequent year-classes appear to have been weaker. However, for those more recent year-classes, the number of fish surviving to ages 6-8 would have been influenced by the commercial and recreational fisheries during 1998-2002. The catch rates at age started to increase again for some ages in 2003 and 2004. This might indicate increasing strength of the year-classes recruiting to the gear, but undoubtedly it also reflects the reduction in mortality following the reimposition of the moratorium in 2003. Thus, the index from the 5½ inch gillnets may provide a good index of abundance, but not necessarily a good measure of relative year-class strength at the older ages that are most strongly selected by the gear.

There are questions regarding the extent of competition between commercial gear and sentinel gear. It is possible that the increase in catch rates in 2003 and 2004 might reflect a reduction in competition. Such competition could include competition for fish and competition for space on the fishing grounds. Questions regarding competition between commercial and sentinel fishing gear have not yet been adequately addressed.

Another factor that might affect sentinel catch rates is the distribution of fish on the fishing grounds. It was frequently stated during the period of declining catch rates that the declines might reflect a decreased availability of fish to the gear, perhaps because the fish were distributed over a greater range of depths. One must ask, then, whether the recent increase in catch rates reflects an increasing availability of fish to the gear. This question of whether there are among-year differences in fish distribution, and whether such differences might affect catch rates, has not yet been adequately addressed.

Small mesh (3¼ inch) gillnets were introduced at many sites in 1996 to provide information on recruitment. As noted above, the size distribution of cod caught by this gear tends to have two modes. The smaller mode tends to be represented primarily by cod of ages 3 and 4. To provide information regarding incoming recruitment, standardized catch rates were computed for cod of ages 3 and 4 combined (Fig. 24). This index declined from 1996 to 1999 and then increased to a level in 2003 that was approximately equal to that in 1996. The index declined again in 2004.

Gillnet catch rate indices by inshore area

As described in Section 7.2.2.2, the inshore of 2J3KL was subdivided into 3 areas (Fig. 1h) for the purposes of this assessment. Standardized catch rates from the 5½ inch gillnets were computed for each of these areas (Fig. 25). In the northern area, mean catch rates have been low since 1995, but were somewhat higher during the late 1990s than during the 2000s. In the central and southern areas, the trends over time were very similar to one another and to the trend in the combined index. In addition, the magnitude of catch rates in the central and southern areas were very similar.

Standardized catch rates were not computed for smaller areas within the three areas reported above. However, information reported by Maddock Parsons and Stead (2005) leads one to suspect that both the central area and the southern area would have regional variability. For the central area, catch rates in Trinity and Bonavista bays would be higher than catch rates in southern 3K, particularly the western side of Notre Dame Bay. For the southern area, catch rates would be higher in St. Mary's Bay than along the eastern Avalon Peninsula and Conception Bay.

5.3 Hydroacoustic survey of Smith Sound

Hydroacoustic studies have been conducted in Smith Sound in western Trinity Bay (Fig. 1g) at various times since the spring of 1995. The quantity of cod detected in the Sound at any specific time will depend not only on the size of the population but also the stage of the seasonal migration pattern. Fish overwinter in deep water in the Sound. Most of them move into shallow water and northward along the coast from late spring to early autumn, and then return to the Sound in late autumn or early winter.

Estimates of the biomass of cod within Smith Sound have varied considerably (Lilly et al. 2003). If one focuses on recent hydroacoustic surveys in January-February, the average index of biomass increased rapidly from about 15,000 t in 1999 to 26,000 t in 2001 and then declined to 23,000 t in 2002, 20,000 t in 2003 and 18,000 t in 2004 (Rose 2003; G. Rose, Memorial University of Newfoundland, St. John's, NL, pers. comm.). The fish sampled during the 2004 survey were of a wide size range (35-120 cm). There was no comparable January-February survey of Smith Sound during 2005.

It is thought that there are additional overwintering aggregations in inlets from Trinity Bay to western Notre Dame Bay (see Appendix 4), but there are no estimates of their size. They are thought to be much smaller than the aggregation in Smith Sound.

6 Population biology

The information on maturity, growth and condition reported in this section is derived from sampling during the autumn offshore bottom-trawl surveys. Additional data are available from sampling of spring surveys in the offshore and sentinel surveys in the inshore, but analyses based on these data were not presented during the 2005 assessment meeting.

6.1 Maturity

The gonads of samples of cod collected during annual DFO autumn bottom-trawl surveys were visually inspected and assigned to the category "immature" or "mature" according to the criteria of Templeman et al. (1978). Visual inspection is not always totally accurate and there can be difficulties in classifying some stages; for example, mature fish that are skipping a spawning year may be erroneously classified as immature or vice-versa, and mature fish that have recently shed a batch of hydrated eggs may be classified as maturing when they are in fact spawning. The extent to which these errors influence the estimation of proportion mature and proportion at each stage of maturation has not been fully evaluated. However, Bolon and Schneider (1999) showed using histological methods that the visual method of classification was reasonably accurate, but tended to slightly underestimate the proportion of spawning fish and overestimate the proportion of maturing fish when spawning was occurring in Placentia Bay (NAFO Subdiv. 3Ps).

Annual estimates of age at 50% maturity (A50) for females from the 2J3KL cod stock, collected during annual autumn DFO research bottom-trawl surveys, were calculated as described by Morgan and Hoenig (1997). Maturation is estimated by cohort rather than by year (Table 33); prior to the 2001 assessment maturation was estimated by year. In addition, data extending back to 1960 have been included in the current analyses. The estimated age at 50% maturity (A50) was generally between 6.0 and 7.0 among cohorts produced in the mid-1950s and around 6.0 among those produced during the late 1960s to the early 1980s, but declined dramatically thereafter to a low of 5.0 for the 1989 cohort (Fig. 26). Age at maturity remained low but variable (4.9-5.7) for the 1990-2000 cohorts, with no clear trend. Males show a similar trend over time (data not shown), but tend to mature about one year earlier than females.

The annual estimates of proportion mature for ages 3-8 show a similar increasing trend (i.e. increasing proportions of mature fish at young ages) through the late 1970s and 1980s, particularly for ages 5, 6, and 7 (Fig. 27). For example, the proportion of 6 yr olds that are mature has increased from about 15% during the early 1960's to 50% in the 1970's and 1980's and to about 80% during the 1990's. The overall age at maturity remains low among 2J3KL cod.

Currently, the age composition of the offshore components of 2J3KL cod remain extremely protracted with very few cod older than age 6. A spawning stock biomass that consists mainly of older fish, or a broad age range, may result in a longer time span of spawning (Hutchings and

Myers 1993; Trippel and Morgan 1994). Older, larger fish also produce more viable eggs and larvae (Solemdal et al. 1995; Kjesbu et al. 1996; Trippel 1998).

Portions of the inshore of 2J3KL have a more extended age distribution with some larger, older cod, particularly around the Bonavista Peninsula, where the ages of cod in the catch extend out to about age 14 or 15. Maturities are available from sampling the sentinel catch in the inshore of 3KL, mainly for cod aged 4 and older. A previous analysis of data collected by the inshore sentinel survey during 1995-1997, fitted by year rather than by cohort, showed a similar low age at maturity to that observed for the offshore portion of the stock (Lilly et al. 1998a).

6.2 Growth

The lengths-at-age and weights-at-age of cod sampled during the autumn surveys confirm the general pattern of a decline in the 1980s and early 1990s as observed in commercial weights-at-age (Fig. 9). The research survey data (Tables 34, 35; Figs. 28, 29) illustrate that the changes varied with Division; there was a strong decline in Division 2J, a lesser decline in Division 3K, and little or no decline in Division 3L. These divisional differences are more apparent in Fig. 30, which focuses on changes in mean lengths and weights of cod of ages 4 and 6. Superimposed on the long-term decline are periods of relatively quicker or slower growth associated with changes in water temperature (Shelton et al. 1999). The trend toward low mean lengths-at-age and weights-at-age in the early 1990s appears to have been reversed during the latter half of the 1990s. Size-at-age has varied without trend in the past few years. Sample sizes at ages greater than age 4 have been very small since about 1992-1994 (Lilly 1998a), so the accuracy of these estimates is likely to be poor

6.3 Condition

Condition can be expressed in various formulations. In this paper it is presented as ($W/L^3 * 10^5$), where W is either the gutted weight of the fish or the liver weight in kg, and L is the length in cm. Arithmetic means by Division, year and age are presented for gutted condition (Table 36; Fig. 31) and liver index (Table 37; Fig. 32).

In Division 2J, both gutted condition and liver index declined in the early 1990s. During the second half of the 1990s gutted condition returned to approximately normal, whereas the liver index improved but did not fully recover. There has been variability with little trend since the mid-1990s.

In Division 3K, gutted condition declined during the early 1990s and improved during the latter half of the 1990s. Liver index changed little during the 1990s. As in Division 2J, there has been variability with little trend since the mid-1990s.

In Division 3L, gutted condition has remained relatively unchanged over time whereas liver index increased considerably in the early 1990s and has since declined to an intermediate level.

Historic trends in condition indices are complex and poorly understood (Lilly 1996, 1997, 2001).

7 Stock trends

As discussed in Section 4, cod in the inshore of Div. 3KL appear to have experienced different dynamics than cod in the offshore of Div. 2J3KL since at least the mid-1990s. In recognition of these differences, the status of cod in the offshore has been presented separately from that of cod in the inshore since the late 1990s.

7.1 Offshore

Information regarding trends in the dynamics of cod in the offshore has come primarily from the research bottom-trawl surveys. Trends in total abundance and biomass in index strata are reported for the autumn surveys in Section 5.1.2.1 and for the spring surveys in Section 5.1.3.1. The present section provides information on spawner stock biomass, recruitment and mortality.

7.1.1 Spawner stock biomass in the offshore

An index of spawner stock biomass in the offshore was derived from catches and sampling during autumn bottom-trawl surveys. Because the surveys were conducted during the autumn, it was thought that the population biomass estimated in a given year would provide an appropriate index for spawner biomass in the following spring. The spawner biomass on January 1 in year y was computed as

$$\sum_{a=1}^{20}(N_{a-1,y-1} \times Pm_{a-1,y-1} \times W_{a,y})$$

where N is population number, Pm is proportion mature, W is individual weight, a is index of age (a=1-20) and year is index of year (y=1984-2005). N was computed by areal expansion of the stratified arithmetic mean catch at age per tow in index strata in Div. 2J, 3K and 3L combined (Table 27). Pm is the proportion of female cod that were mature, as estimated from a probit model fitted by cohort to observed proportions mature at age (see Section 6.1). W is the weight on January 1 as estimated from mid-year commercial weights (updated from Table 11 of Lilly et al. 2003). Weights derived from sampling of the commercial catch are used so as to be consistent with the weights used in the inshore SPA (see Section 7.2.2.2). Note that the computation of spawner biomass as described here differs from computation of the total biomass as illustrated in Fig. 14 in the use of commercial weights-at-age, rather than the actual weights-at-age in the survey catches, and in extrapolation from a mean catch per tow rather than a summation of biomass estimates calculated for individual strata. (Recall that some strata were not surveyed in some years.)

The index (Fig. 33) declined quickly after 1990 to reach a minimum in 1995. There was a slight increase during the late 1990s followed by greater among-year variability in more recent years. Despite the increase in proportion of fish mature at age (Section 6.1) and the increase in commercial weights at age (Section 2.6), the average index during the most recent three years was only 1% of the average index in the period 1984-1989 (excluding the high value in 1987).

7.1.2 Recruitment in the offshore

The weakness of recent year-classes is emphasized when mean catch at age per tow (Table 27) is plotted for the 1976-2003 year-classes at ages 1-3 (Fig. 34). For age 1, year-class strength declined from 1994 to 1996, increased to 1999, and then fluctuated without trend. The catch rates of some of these year-classes appear strong at age 1 compared with year-classes prior to 1994, but of course this is simply a reflection of the weak ability of the Engels trawl to catch small fish. The catch rates of many of the earlier year-classes appear much stronger when converted to Campelen equivalents, and even this underrepresents their relative strength, because zero catches cannot be converted.

By age 3 all year-classes from 1992 to 2001 look weak even when compared with unconverted catches of some of the year-classes from the early and late 1980s. Note that the 1994 and 1999 year-classes, which were relatively strong at age 1, do not appear relatively strong by age 3.

7.1.3 Mortality in the offshore

Information on the rate at which fish are dying is available from a number of sources, including total mortality estimated from offshore survey data (this section), fishing mortality and natural mortality estimated for fish in the inshore from tag return data (Section 7.2.1) and fishing mortality estimated for fish in the inshore from an inshore SPA (Section 7.2.2.2).

Total mortality rates at age in each year, $Z_{a,y}$ (Fig. 35) were estimated from catch rate at age per tow during the autumn research bottom-trawl surveys in 2J3KL (combined) by applying the following equation:

$$Z_{a,y} = -\ln(RV_{a,y} / RV_{a-1,y-1})$$

where ages (a) = 2 to 15 and years (y) = 1984 to 2004. For example, mortality of the 1991 year-class from the autumn of 1996 to the autumn of 1997 (Z = 2.16) is referenced to age 6 in 1997. This is intended to reflect the likelihood that most of the deaths experienced by the 1991 year-class from autumn 1996 to autumn 1997 will have occurred in 1997.

There is considerable variability in these data (Fig. 35). Prior to the collapse the various age groups tended to follow the same pattern, reflecting both trends in mortality and among-year variability (year effects). The most extreme instance of a year effect was the anomalously high index value in 1986, which resulted in the appearance of production of fish (negative mortality) from 1985 to 1986 and the appearance of very high mortality from 1986 to 1987. Since the collapse of the stock, the Z's are characterized by some year effects, but none as dramatic as in the latter half of the 1980s. This is considerable additional variability which is probably a consequence of sampling error associated with very low population level.

To illustrate more clearly the trend in total mortality over time, the data for just two ages (4 and 6) are isolated in Fig. 36. In this figure the data are presented as age specific mortality rates (proportion of fish dying in a year) rather than as instantaneous rates because it was thought that many people may be better able to interpret a death rate of 0.88 than an instantaneous rate of 2.16. Note that only data collected since the change to the Campelen trawl are illustrated in the Stock Status Report.

Despite the absence of a directed fishery in the offshore, mortality at younger ages has remained very high (0.4-0.6 per year at age 4 and 0.6-0.9 per year at age 6). Note that the mortalities computed from survey catches should be interpreted as indicators of trends over time, rather than absolute values. Rates calculated for younger ages (e.g. from age 2 to age 3) may underestimate mortality for two reasons: the proportion of a year-class available to the survey increases with age as the fish move to the offshore from inshore nursery grounds, and the proportion of the available fish caught by the trawl increases with fish length.

Factors that may be contributing to the high apparent mortality in the offshore are not well understood. Some of the hypotheses that have been proposed are discussed in Appendix 6.

7.2 Inshore

7.2.1 Exploitation rates from tagging

This section discusses only those tagging studies conducted since the collapse of the stock. Some tagging studies were conducted by sentinel fish harvesters during 1995 and 1996, and DFO technical staff conducted tagging in Trinity Bay in 1995. A new series of tagging studies, conducted entirely by experienced DFO technical staff, was initiated in 2J3KL and 3Ps in 1997. These studies provide information on migration patterns and exploitation rates.

Within the northern cod area, cod aggregations of sufficient size to warrant tagging have not been found in the offshore or in the inshore of 2J and northern 3K. However, 134 individual tagging studies comprising almost 38,000 tagged cod have been conducted since 1995 in the inshore from central Notre Dame Bay in 3K to St. Mary's Bay in southern 3L. For the experiments conducted from 1997 onward, almost 28,000 cod were tagged and released and approximately 5,100 were reported as recaptured by early 2005 (Brattey and Healey 2005).

As described by Lilly et al. (2003), two approaches have been employed to estimate exploitation rate from the tag return data. One method (Brattey and Healey 2003) estimates annual exploitation of the fish tagged within each tagging experiment. This calculation takes into account all recaptures, irrespective of where and when the recaptures occurred. (For example, for a tagging experiment conducted in Smith Sound, the exploitation rate for that experiment would be calculated from all recaptures within a specific year. This would include not only those fish recaptured within Smith Sound, but also all those recaptured as the fish went through their annual migration out of Smith Sound, perhaps as far as Notre Dame Bay, and then back to the Sound.) The second approach attempts to estimate the exploitation rate of cod within a specific area and time when the commercial fishery has been open. With this approach, the exploitation is calculated from the recovery rate of all fish that are estimated to be within the area during the specified period. (For example, the exploitation rate that is calculated for 3K for a specific period in time would be based not only on fish that were tagged within 3K, but also fish that were estimated to have moved into 3K from other areas, such as northern 3L, southern 3L and even 3Ps. There would also be allowance for fish that were tagged within 3K but moved elsewhere.)

7.2.1.1 Exploitation rates from individual tagging studies

The annual exploitation rate was estimated for each tagging experiment in 3KL and summarized by geographic area (Brattey and Healey 2003, 2005). Fisheries were very small in 2003 and 2004, so the number of tag returns was small.

A total of 497 tags were returned from 3KL in 2003 (418 of these came from the Smith Sound mass mortality). Estimates of exploitation for cod tagged in 3K or 3La were low (<5%), but were marginally higher (5-8%) for some groups of cod tagged in southern 3L (3Lq) due to recaptures in 3Ps where the directed cod fishery remains open. A notable result was the high 2003 estimates (10-24%) for 11 of 22 experiments that involved release of tagged cod in 3Lb during 1999-2002. Most of the tag returns came from the mass mortality of cod in Smith Sound in April. This event resulted in mortality of a substantial proportion of the cod that had been tagged in the local area in recent years.

Only 66 tags were returned during 2004, and all estimates of exploitation were low (<6%).

7.2.1.2 Exploitation rates and exploitable biomass in specific areas

Exploitation rates and exploitable biomass were estimated by Cadigan and Brattey (2003) for specific areas during periods when the commercial fishery was open in 1999-2002. The exploitation rates were estimated as the number of tagged fish caught and reported, divided by the number of tagged fish estimated to be available, with adjustments for reporting rate, tagging mortality and tag loss. The number of tagged fish available to be caught by a specific gear type within a specific area and time interval was estimated from the tagging data, individual growth, gear selectivity and a model of rates of movement of fish among areas. There were eight geographic areas in the model. Three of these are within the northern cod stock area: inshore Div. 3K, inshore northern Div. 3L (Bonavista and Trinity bays) and inshore southern Div. 3L (Conception Bay, the eastern Avalon Peninsula, and St. Mary's Bay).

The results, as reported by Cadigan and Brattey (2003), are complex. In brief, the results of the analysis indicate that harvest rates averaged 10% of the exploitable biomass (approximately ages 4+) in the central inshore region from 1999 to 2002 associated with an average reported catch of 5,000 t. Based on these harvest rate estimates, exploitable biomass from 1999 to 2002 averaged approximately 50,000 t with no clear trend. See Cadigan and Brattey (2003) and Lilly et al. (2003) for additional discussion.

It was not possible to estimate exploitation, natural mortality, and migration rates for 2003 and 2004 from tagging information because of the limited catch, tag returns and much reduced tagging of cod in those years.

7.2.1.3 Evidence of high natural mortality based on tagging data

The exploitation rates estimated from tagging experiments that were conducted in Notre Dame Bay (3K) and Bonavista Bay (3La) up to 2002 (Brattey and Healey 2003) tended to be high in the year of tagging and then to decline in subsequent years, even though exploitation rates from tagging in later years tended to be high in the year when those additional tags were applied. For example, for cod tagged in 3K in 1999 the estimates of exploitation for 1999 varied among experiments from 30% to 63%, but the estimates declined to zero by 2002 when none of the cod tagged in 1999 were recovered. However, additional cod were tagged in 3K in 2002 and the estimates of exploitation during 2002 ranged from 12% to 20%. This indicates that the cod tagged in 1999 disappeared or were no longer available to the fishery by 2002. This phenomenon was more evident in 3K than in 3La. One possible explanation is that the proportion of the cod available to the fishery declined faster than estimated. This could be due to a movement out of the area, perhaps to the south or even to the offshore. A movement southward, perhaps to the Smith Sound population, is possible. A movement to the offshore seems unlikely, since very few cod of commercial size have been caught during the offshore research vessel surveys. A second possible explanation for the phenomenon above is that the level of natural mortality (assumed to be 0.2) has been set too low.

In contrast to findings in 3K and 3La, exploitation rates from specific tagging experiments in Trinity Bay (3Lb), and especially in Smith Sound, tended to increase over time. It seems that "disappearance" of cod was less noticeable for cod in Smith Sound.

This problem of the "disappearance" of cod was addressed by Cadigan and Brattey (2003), who made *ad hoc* adjustments to the level of natural mortality in their model to improve the fit between model output and the input data. They found that the best fit was achieved with an instantaneous natural mortality (M) of 0.8 in inshore 3K and 0.4 in both inshore northern 3L and inshore southern 3L.

The exercise of trying to determine the value of natural mortality (Cadigan and Brattey 2003) was repeated for the present assessment. This involved adjusting values for natural mortality (M) to remove trends in the number of tagged cod returned compared to estimates of the returns based on the assumed M. For example, in Figs 37 and 38 residuals are shown for returns from cod tagged in 3K_IN and 3L_INN based on M=0. Most cod tagged in these regions were also recaptured in these regions. The results for 2003-04 are discounted because of the low numbers of tag-returns in these years. Decreasing trends are clearest for 3L_INN in the bottom panel of Fig. 38. This indicates that the tagging model predicts more recaptures than observed as time-at-liberty (i.e. years) increases. The tagging model does not apply sufficient mortality to "explain" or match the observed decline in tag-recaptures. Over time this causes the model to under-predict the number of recaptures from more recent experiments because each year the total residual is zero; that is, the exploitation rate in a year is based on recaptures from all previous releases, and by construction the total observed recaptures from all previous releases must equal the total predicted recaptures. The trends in the bottom panel of Fig. 38 are consistent with a misspecification of M and suggest that M>0. Note that there are similar trends in 3K_IN (top panel of Fig. 38) and this suggests that the residual trends for 3L_INN are not because more fish have moved to 3K_IN than the model has estimated. Decreasing trends in residuals are also evidence for recaptures of cod tagged in 3K_IN (Fig. 37; top panel), although the trends are not as consistent as in Fig. 38.

In the 2003 assessment the values of M were adjusted to reduce or remove the residual patterns. The values selected were M=0.8 for 3K_IN and M=0.4 for 3L_INN. Residuals for these values are shown in Figs 39 and 40. The M value for 3L_INN may be too high because the residuals trends (Fig. 40; bottom panel) increase which suggests that too much mortality is applied in the tagging model because the predicted recaptures over time are less than the observed recaptures. There is also some evidence that M=0.8 is too high in 3K_IN (Fig. 39; top panel) because residuals tend to increase in the first year after release. The 3K_IN results are more variable because of the lower numbers of tagged cod in this area.

Residuals were examined based on M=0.5 in 3K_IN and M=0.2 in 3L_INN (Figs 41 and 42). Decreasing trends were still apparent, although less than in Figs 37-38 when M=0 in both regions.

The conclusion for the above analyses was that M in 3K_IN was between 0.5 and 0.8, and M in 3L_INN was between 0.2 and 0.4. Values of M=0.65 (annual mortality rate of 48%) in 3K_IN and M=0.3 (26%) in 3L_INN were considered to be appropriate for the period 1997-2002.

7.2.2 Sequential population analysis (SPA)

7.2.2.1 Very brief history of SPAs for 2J3KL cod

Whole-stock SPAs

The history of assessments of 2J3KL cod, from 1977 until the moratorium in 1992, is reported in considerable detail by Bishop and Shelton (1997). Results from the various SPAs explored during the assessment meetings in 1992 were used in projections of stock size under different levels of fishing mortality, even though a problem of lack of model fit in the most recent years was a serious concern (Baird et al. 1992a). The SPA in 1993 (Bishop et al. 1993) had a severe residual pattern and was not used as a basis for projection. By 1994 the residual pattern was so strong (Bishop et al. 1994) that it was concluded that the results did not adequately represent stock abundance. That is, the SPA was rejected. An SPA was again attempted in 1996 (Shelton et al. 1996), and again the residual pattern was so severe that it was considered that the results were "illustrative" of the population dynamics, but were not sufficiently well estimated to allow the projection of stock size. "Illustrative" SPAs were explored again in 1997, when the results were used as the basis for a projection to evaluate an F0.1 control rule (Murphy et al. 1997), and in 1998, when a tentative risk analysis was attempted (Lilly et al. 1998b).

An analytical assessment was not attempted in 1999 (Lilly et al. 1999). The inability to reconcile reported catches and the research vessel index in the late 1980s and early 1990s had not been resolved. In addition, it was felt that the research vessel bottom-trawl index, the only long-standing fishery-independent index available for this stock, may no longer be representative of the stock as a whole. It was thought that the index was adequately reflecting the status of the stock in the offshore, which constitutes the vast bulk of the stock area, but was not reflecting the status of cod found on traditional inshore fishing grounds from White Bay to St. Mary's Bay. It was decided that an analytical assessment of the inshore alone was not possible because inshore catches prior to the moratorium could not be apportioned into those coming from inshore components and those coming from components that migrated into the inshore from the offshore.

An analytical assessment was not attempted in 2000 (Lilly et al. 2000b).

In 2001, several attempts were made to combine catch data and various indices in an SPA for the whole stock (Lilly et al. 2001; Morgan 2001). The formulations incorporated new indices from the inshore (research vessel inshore, sentinel gillnet and sentinel linetrawl) along with the autumn and spring research vessel offshore indices, but the attempts were considered unsuccessful. As noted above, during the latter half of the 1990s and early 2000s a high (but unquantified) proportion of the cod in the stock area was in the inshore, and almost all the catch was taken in the inshore. Thus, the offshore bottom-trawl survey no longer reflected a consistent proportion of the stock. Various new indices from the inshore were now available, but these were of short duration. Even if these indices were of longer duration, it is likely that they too would be considered not to reflect a consistent proportion of the stock because of their limited geographic coverage.

It is important to note that one of the models examined during the 2001 assessment meeting addressed the concern regarding the poor fit between SPA model estimates and the offshore research vessel index. Shelton and Lilly (2000) computed the number and age of fish that would have to be added to the reported catch during several years in the early 1990s to make the catch fit the survey index, without relaxing standard assumptions regarding natural mortality and catchability. P. Shelton has used this "missing fish" model in various exercises, most notably for computing metrics of population change in the provision of information to COSEWIC (Smedbol et al. 2002). Assumptions in this model result in the appearance of a stock collapse that was a little later than the collapse depicted by models that did not have added catch (e.g. Bishop et al. 1993; Lilly et al. 1998b). In addition, the 1986 and 1987 year-classes, which initially seemed to be strong at age 3 in SPA estimates (Baird et al. 1991a) but later (after their rapid disappearance from the surveys) seemed much weaker (Bishop et al. 1993, Lilly et al. 1998b), appear in the "missing fish" model to be strong (Morgan et al. 2000; Smedbol et al. 2002). This variability in perception is particularly dramatic for the 1987 year-class. Thus, the history of stock dynamics during the latter half of the 1980s and the early 1990s differs between the "missing fish" model and models that have not been altered by the addition of a substantial quantity of unreported catch.

Inshore SPA

During the 2001 assessment meeting (Morgan 2001), it was suggested that, with additional time, it may be possible to use the inshore bottom-trawl survey and the sentinel surveys to tune an inshore SPA. A suggested approach would be to ignore the historic catch data and construct an inshore assessment using the most recent data in isolation. This was attempted in 2003.

Several models and formulations were explored. An analysis using ADAPT incorporated catch at age for ages 2 to 10 for years 1995-2002, mean numbers per tow from the autumn stratified random bottom trawl survey in inshore strata for ages 2 to 9 and years 1996 to 2002 (with the exception of 1999 when no survey was carried out), sentinel survey 5½ inch gillnet catch rate index for ages 3 to 9 for years 1995 to 2002, sentinel survey 3¼ inch gillnet catch rate index for ages 2 to 9 for years 1996 to 2002, and sentinel line trawl catch rate index for ages 3 to 9 for years 1995 to 2002. It should be noted that this SPA was based on all catches taken in 2J3KL, including cod that overwintered in 3Ps. That is, the SPA represents more than the resident coastal group that overwinters within 3K and 3L (primarily northern 3L).

7.2.2.2 SPA for resident inshore cod

Determination of geographic area for SPA

The remit for this assessent (Appendix 1) requests a determination of the current status of cod in the inshore and an assessment of the implications of inshore fishery removals varying from zero to 5,000 t annually in 2005 and the medium term. As noted in Section 4, tagging studies have revealed that in southern 3K and in 3L there are currently two main groups of cod in the inshore; (1) resident fish that overwinter in northern 3L and southern 3K and undertake seasonal migrations among Trinity, Bonavista and Notre Dame bays and (2) migratory fish that overwinter in inshore and offshore areas of 3Ps, move into southern 3L in the spring-summer and return to 3Ps in the autumn. It is thought that migrants from offshore 2J3KL currently contribute little to the biomass of cod in the inshore of 2J3KL.

The concensus of the meeting was that it was not possible with current information to predict the quantity of cod that will move into 3KL from 3Ps in any given year. (The quantity migrating from 3Ps to 3KL would depend on the size of each of the various stock components that occur within 3Ps in winter and the proportion of each component that crosses the 3Ps/3L boundary during spring/summer.) Therefore, for the purpose of the present assessment, the inshore is subdivided into three areas (Fig. 1h): 1) a northern area (2J and northern 3K) that contains relatively few cod; 2) a central area (southern 3K and northern 3L) where most of the resident inshore fish are located; and 3) a southern area (southern 3L) that is, at present, largely dependent on cod that overwinter in inshore and offshore areas of 3Ps, move into southern 3L in the spring-summer and return to 3Ps in the autumn.

The boundary line between the northern and central areas was placed at Partridge Point, which is the headland of demarcation between statistical unit areas 3Kh and 3Ki (see Fig. 1d for an illustration of the unit areas). This headland was chosen based on visual inspection of various plots of the return patterns from tagging studies in southern 3K and 3L. It was found that very few cod were recaptured in unit areas to the north (Brattey and Healey 2005). The boundary line between the central and southern areas was placed at Grates Point, which is the headland of demarcation between statistical unit areas 3Lb and 3Lf. This headland was chosen based on tag return patterns, which illustrate that few fish tagged within and to the north of Trinity Bay (3Lb) are recaptured to the south.

SPA model structure

Several SPA analyses were evaluated by the RAP meeting; the agreed ADAPT inputs and run structure follow.

The catch at age matrix was recomputed for all 3K plus 3L north (3La and 3Lb). The matrix has ages 2 to 10+ (where 10+ is 10-20) for years 1995-2004 (Table 38). Note that this catch includes a small quantity from 3Ka and 3Kd, which are outside the central inshore area. The catch from these external areas contributed on average just 3% of the total annual catch used in the modelling.

The standardized sentinel catch rate at age indices were recomputed for just sites within the central inshore area (3Kh, 3Ki, 3La, 3Lb). These sites were Coachman's Cove to Heart's Content, inclusive. All three sentinel catch rate indices were used to estimate population abundance: the 5½ inch gillnet index (ages 3-9), the 3¼ inch gillnet index (ages 3-9), and the linetrawl index (ages 3-7) (Table 39). Note that the age ranges included are somewhat different from those included in the 2003 assessment formulation. The age 2 estimates for the 3¼ inch gillnet index were excluded due to poor fit in previous analyses. The linetrawl indices at ages 8 and 9 were excluded because half of the data values are zero; these are treated as missing data within ADAPT.

Note as well that the index of catch rates at age from the research vessel inshore strata in 3KL, which had been incorporated in the SPA during the 2003 assessment, has not been included. During visual inspection of plots of the inshore catch rates at age, it was noted that year effects were stronger than cohort effects. There was also concern that the spatial coverage of this index does not overlap with the spatial distribution of the majority of the landings from the central inshore portion of the stock area. Nevertheless, the index was recomputed for just those strata in the inshore of 3K plus 3L north (3La and 3Lb). The recomputed index was included in some ADAPT runs, but was found to have a severe residual pattern. For the above reasons, the inshore research vessel index was omitted from the SPA.

An average of the natural mortality (M) values for 3K_IN and 3L_INN (see section 7.2.1.3) was used for the SPA. In the 2003 assessment the overall M was taken as 25% of M in 3K_IN plus 75% of M in 3L_INN, and the result was 0.5. Based on the new values of M inferred from tagging in this assessment, the weighted-average is $0.25 \times 0.65 + 0.75 \times 0.3 = 0.39$. It was considered that a value of 0.4 (33%) is appropriate for cod in the central portion of the inshore. (Note that if all high-reward tags on captured cod are reported so that reporting rate estimates are reliable then the M inferred from tagging only represents "true" natural mortality, and not mortality due to unreported catch. The latter mortality, if it exists, would still need to be accounted for in SPA, and if not the SPA may be biased.)

The abundance of age classes 4-10+ are estimated for Jan.1, 2005.

F-constraints using the FRATIO method of ADAPT are applied to complete the remaining cohorts. Using this method, the ratio of the fishing mortality on the plus-group (10+) relative to the oldest true age (age 9) is estimated or assigned. In this analysis, there are three FRATIO parameters: a common F-ratio over 1995-2002, an F-ratio parameter for 2003, and an F-ratio parameter for 2004. The 2003 and 2004 parameters are considered separately due to unusual catch circumstances in those years: in 2003, the majority of the catch came from the Smith Sound mass mortality; in 2004, removals were primarily by-catches from a winter (blackback) flounder fishery that used gillnets of larger mesh size than those typically employed in directed cod fisheries (Section 2.3). Based upon results of previous ADAPT analyses considered at the RAP meeting (not shown), these F-ratio parameters were fixed at values of 0.67, 1.58 and 1.00, respectively.

SPA model output

Table 40 provides the ADAPT estimates, with associated bias and standard errors. The relative error of most parameters is about 20%. However, the abundance estimates for ages 4 and the 10+ group have relative errors of approximately 30%. Estimates of bias-adjusted abundance at age and fishing mortality at age are given in Tables 41 and 42, respectively. Spawning stock biomass was computed from the bias-corrected numbers at age at the beginning of the year, cohort model estimates of proportion mature at age from survey data, and beginning of year weights-at-age derived from commercial sample data.

Both 4+ biomass and spawner biomass increased during the first moratorium on directed commercial fishing, but subsequently declined as commercial fisheries reopened (Fig. 43, 44). After the imposition of the second moratorium, the 4+ biomass and spawner biomass increased once again.

Estimates of fishing mortality (average of ages 5-10+, Fig. 45) were low from 1995 to 1997 when the directed fisheries were closed (except for a small food/recreational fishery in 1996). During the period of the index/commercial fisheries (1998-2002) there was a variable but increasing trend in fishing mortality. Landings from the mass mortality event in Smith Sound during the spring of 2003 indicate a level of "fishing" mortality comparable to that during 1998 when the directed fishery was first reopened. This reflects not only the number of fish killed during the event but the fact that a high proportion of the fish were relatively old (see Sections 2.3 and 2.6). The fishing mortality estimated for 2004 is relatively low.

Estimates of recruitment at age 3 (Fig. 46) suggest that the 1992 and 2000 year-classes have been substantially stronger than all other year-classes throughout the time period of this SPA.

Residual plots from the ADAPT analysis are presented in Fig. 47. These plots suggest that the model fit is acceptable; however there is some evidence of year effects (Fig. 47c).

8 Conclusions and advice

This section focuses on the implications of reopening an inshore fishery.

8.1 Inshore fishery and inshore population growth

One of the many uncertainties regarding this exercise is the magnitude of the year-classes that will enter the exploitable portion of the stock over the next few years. The 3¼ inch mesh sentinel gillnet index was designed to provide an index of incoming year-classes but, as noted above, age 2 estimates from this index were excluded from the SPA tuning due to poor fit. Catch rate information is also available for ages 0-2 from the inshore portion of the research bottom-trawl survey (Section 5.1.2.2.2), and catch rates at ages 0 and 1 are available from beach seining in Bonavista Bay (Gregory et al. 2006). Some data from the various indices suggest that the 2002 year-class was at least moderately strong, but other data do not indicate such strength. The beach seining indicates that the 2003 and 2004 year-classes may be weak.

Inshore central area

Deterministic projections of stock size from 2005 to 2006, 2007 and 2008 were computed from the SPA results for the inshore central area (southern 3K and northern 3L). Projections were conducted under catch options of 0 t, 2,500 t, and 5,000 t. Due to uncertainties in future recruitment, three values (low, medium, and high) were considered in the projections. The low recruitment value was the minimum estimate from 1995 to 2003 of age 2 abundance from the SPA; medium recruitment was the 2001-2003 geometric mean; and high recruitment was the maximum estimated value (at age 2) in the SPA. The value of natural mortality used in the projections was the same as that in the SPA (M=0.4). An average partial recruitment vector from 2000-2002 (i.e. prior to the second moratorium) was applied in the projection. The projection weights at age are averages of the values in 2002 to 2004. The above input parameters are summarized in Table 43.

The projection of spawner biomass from 2005 to 2006 is insensitive to the assumed value of recruitment. With no removals or a catch option of 2,500 t, spawner biomass is projected to increase, regardless of the assumed recruitment level (Table 44a). This is the result of the relatively strong 2000 year-class entering into the spawner biomass. At a catch option of 5,000 t, spawner biomass is projected to decrease.

In the three year projection (from 2005-2008), assuming no removals, spawner biomass is projected to increase for each recruitment assumption (Table 44b). At a catch option of 2,500 t, spawner biomass is projected to decrease if recruitment is low, but increase if recruitment is medium or high. At a catch option of 5,000 t, spawner biomass is projected to decrease for each of the recruitment scenarios. Trajectories of spawner biomass for each recruitment option and catch option are illustrated in Fig. 48.

Projection results are dependent, of course, on the values of all variables used in the computations, but particular note is made of the high (0.4) value of natural mortality applied in both the SPA and the projections. There is insufficient information on spatial and temporal variability in natural mortality to explore informative alternatives. However, if future natural mortality differs from the assumed value, then the projected changes in SSB will differ from the above results.

Inshore northern area.

For the inshore northern area (2J plus northern 3K), it is inferred from the low catch rates in the sentinel surveys (1995-2004) and the commercial fishery (1998-2002) that cod densities are very low. Any catch option would likely impose high fishing mortality and further reduce stock size in this area.

Inshore southern area

For the inshore southern area (southern 3L), it is clear that catch rates have been relatively high at certain times and in some areas. The tagging data illustrated that fisheries in the area during 1998-2002 were primarily dependent on seasonal immigration. Since the magnitude of immigration in future years cannot be predicted, the effect of removals of various levels cannot be estimated. However, fisheries in southern 3L will contribute additional mortality to groups of fish that migrate between Placentia Bay and southern 3L. These fish already experience high fishing mortality within Placentia Bay.

8.2 Inshore fishery and offshore recovery

Under a precautionary approach, conservation limit reference points indicate when a stock is considered to have impaired productivity and is thus in a situation in which serious harm has occurred. The biomass of the 2J3KL cod stock as a whole is not known, but it is clearly far below any limit reference point. A spawning stock biomass limit reference point has not been identified for 2J3KL cod, but it was anticipated that the limit would be higher than 300,000 t for the stock as a whole (Rivard and Rice 2002). Given the lack of any recovery in the offshore during the past decade, it is clear that the productivity of the stock as a whole is seriously impaired.

The risk of fishing the inshore populations extends beyond a consideration of limit reference points. There is a strong possibility that cod currently offshore in 2J3KL undergo spring/summer feeding migrations to the inshore. At current offshore population levels, the capture of any offshore fish in an inshore fishery could further impede recovery in the offshore. Many of the fish historically caught in the inshore were immature, so inshore removals may capture some offshore fish before they have a chance to spawn.

The potential for cod currently in the inshore to repopulate the offshore of 2J3KL remains uncertain. Genetic studies using microsatellites have demonstrated a population substructure between most inshore and offshore areas. It has been suggested that this substructure indicates a low likelihood that inshore-spawning cod will contribute to offshore recovery (Beacham et al.

2002). However, evidence of substructure may not preclude inshore-spawning cod playing a role in future offshore recovery. If fish currently in the inshore could recolonize the shelf, then allowing the inshore biomass to increase makes it more likely that inshore fish may move offshore.

In consideration of the above, there is a risk that fishing in the inshore will impede recovery in the offshore.

8.3 Regional vulnerability to exploitation

There may be numerous over-wintering inshore populations, with the largest by far being that in Smith Sound. Small populations of cod residing adjacent to large populations of fish harvesters (such as in parts of Notre Dame Bay) are more vulnerable to over-exploitation than the relatively large population in Smith Sound. To protect small populations, it is essential that removals be kept low in areas of low cod density.

9 Other considerations

The ecosystem in which the 2J3KL cod stock is but one component has experienced dramatic changes since the 1980s. The relative importance of fishing, physical environment and biological interactions in causing and sustaining those changes is difficult to discern.

9.1 Physical oceanography

The marine environment off Labrador and eastern Newfoundland has experienced considerable variability since the start of standardized measurements in the mid-1940s (Colbourne and Anderson 2003; Colbourne 2003). A general warming phase reached its maximum by the mid-1960s. Beginning in the early 1970s there was a general downward trend in ocean temperatures, with particularly cold periods in the early 1970s, early to mid-1980s and early 1990s. Ocean temperatures started to warm in 1995. The decade of the 1990s experienced some of the greatest extremes, with particularly cold conditions in 1991 and very warm conditions in various years of the late 1990s. There have also been extremes within a year, as illustrated by the particularly cold winter and unusually warm summer/autumn of 2003.

Water temperatures remained above normal in 2004, reaching record highs in some areas (Colbourne et al. 2005). Ice coverage during 2004 was the second lowest in 42 years, and its duration was generally less than average (Petrie et al. 2005).

No new information regarding the influence of physical oceanography on cod biology and dynamics was presented to the meeting. An overview of studies regarding the role of the environment in the collapse of 2J3KL cod is provided in Appendix 5, and an overview of hypotheses concerning the non-recovery of 2J3KL cod is provided in Appendix 6.

9.2 Predators

A wide variety of predators are known to consume cod, mainly during the cod's juvenile stages (Pálsson 1994; Bundy et al. 2000). Cannibalism is well documented for 2J3KL cod and is thought to be an important source of mortality in some cod stocks (Bogstad et al. 1994). However, the predator that has attracted the most interest and concern in recent years is the harp seal.

No new information regarding the impact of seals on the dynamics of cod was presented to the meeting. Previous cod assessments (DFO 2003) have concluded, based on seal feeding behaviour and trends in the abundance of both seals and cod, that predation by seals is a factor contributing to the high total mortality of cod in the offshore and the high natural mortality of adult cod in the inshore.

Estimates of the quantity of cod consumed by harp seals are based on estimates of harp seal population numbers, energy requirements of individual seals, the average duration of seal occurrence within 2J3KL, the relative distribution of seals between inshore and offshore, and stomach contents of seals sampled in the inshore and offshore in winter and summer. A major shortcoming is that there are very few stomach samples from the offshore, where most of the feeding by seals occurs. A two-year programme of enhanced study of seals is in progress. This programme includes new population surveys, new studies of distribution, and new studies of diet, both inshore and offshore.

The estimates of prey consumption by seals rely on the presence and identification of hard parts (such as cod otoliths) in the seal stomachs. Seals also prey on cod by belly-feeding, a mode of predation on fish which are usually too large to be consumed whole. The seal takes a bite from the belly of the fish, removing the liver and gut, but not consuming the muscle or hard parts. Observations of belly-feeding were more frequent during 1998-2000 than in recent years, and occurred mainly in Notre Dame Bay and southern Bonavista Bay. A participant in this cod assessment meeting reported that belly-feeding is still occurring in Smith Sound (Trinity Bay).

A pilot study on the efficacy of seal exclusion zones is currently underway in Smith Sound (Bowen 2004).

Some discussion regarding the interaction between seals and cod is presented in an overview of hypotheses concerning the non-recovery of 2J3KL cod (Appendix 6). Additional information regarding seals and cod is presented in Appendix 7.

9.3 Prey

Cod feed on a wide variety of prey (Lilly 1987). The major prey for small cod are planktonic crustaceans, notably hyperiid amphipods in the north and euphausiids on Grand Bank. For medium-size cod the major prey are schooling planktivorous fish. The most important of these is capelin, but Arctic cod are eaten in the north, herring are consumed in inshore waters, and sand lance are important on Grand Bank. Larger cod tend to feed on medium-sized fish and crabs, especially toad crabs and small snow crabs. Shrimp are consumed by a broad size range of cod. Cod also feed on smaller cod, but cannibalism is not an important aspect of the diet of northern cod.

The prey that has received most attention is capelin. The trend in biomass of capelin, historically the major prey of cod in 2J3KL, has been uncertain since the late 1980s. Biomass estimates from hydroacoustic surveys in the offshore have been much lower since the early 1990s compared with the 1980s, but indices of capelin biomass from the inshore have not shown such extensive declines. Some studies of cod condition and feeding indicate that cod may not be faring well in certain seasons and areas, and that this is due to low availability of capelin. Other studies and observations do not suggest any concerns at present about cod growth or condition. Whatever the present circumstances, there remains concern that there may not be sufficient capelin to support a recovery of the cod stock, especially in the offshore and in the north.

Some discussion regarding the interaction between cod and capelin is presented in an overview of hypotheses concerning the non-recovery of 2J3KL cod (Appendix 6). Additional information regarding cod and capelin is presented in Appendix 8.

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(NOTE: This reference list includes papers cited in the Appendices.)

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Table 1. Landings (t) of cod from NAFO Divisions 2J3KL for the period 1959-2004.

	2J				3K				3L				2J3KL			
	Offshore mobile gear		Fixed gear		Offshore mobile gear		Fixed gear		Offshore mobile gear		Fixed gear					
Year	Canada	Other	Canada	Total	Canada	Other	Canada	Total	Canada	Other	Canada	Total	Total Canada	Total Other	Total	TAC
1959	0	46372	17533	63905	0	97678	56264	153942	4515	51515	85695	141725	164007	195565	359572	
1960	1	164123	15418	179542	53	74999	47676	122728	7355	63985	94192	165532	164695	303107	467802	
1961	1	243144	17545	260690	0	64023	31159	95182	4675	73899	70659	149233	124039	381066	505105	
1962	0	226841	23424	250265	0	47015	42816	89831	4383	90276	72271	166930	142894	364132	507026	
1963	1	197868	23767	221636	0	79331	47486	126817	4446	83015	73295	160756	148995	360214	509209	
1964	13	197359	14787	212159	0	121423	40735	162158	10158	142370	75806	228334	141499	461152	602651	
1965	0	246650	25117	271767	21	50097	26467	76585	7353	130387	58943	196683	117901	427134	545035	
1966	39	226244	22645	248928	13	58907	32208	91128	8253	120206	55990	184449	119148	405357	524505	
1967	28	217255	27721	245004	114	78687	24905	103706	13478	200343	49233	263054	115479	496285	611764	
1968	4650	355108	12937	372695	1849	119778	40768	162395	15784	211808	47332	274924	123320	686694	810014	
1969	30	405231	4328	409589	56	80949	24923	105928	18255	151945	67973	238173	115565	638125	753690	
1970	0	212961	1963	214924	92	78274	21512	99878	14471	137840	53113	205424	91151	429075	520226	
1971	0	154700	3313	158013	31	61506	21111	82648	11976	148766	38115	198857	74546	364972	439518	
1972	0	149435	1725	151160	7	133369	14054	147430	4380	109052	46273	159705	66439	391856	458295	
1973	1123	52985	3619	57727	108	159653	13190	172951	1258	97734	24839	123831	44137	310372	354509	666000
1974	0	119463	1804	121267	19	149189	10747	159955	880	67918	22630	91428	36080	336570	372650	657000
1975	410	78578	3000	81988	189	112678	15518	128385	670	53770	22695	77135	42482	245026	287508	554000
1976	94	30691	3851	34636	771	79540	20879	101190	2187	40998	35209	78394	62991	151229	214220	300000
1977	525	39584	3523	43632	1051	26776	28818	56645	5362	26799	40282	72443	79561	93159	172720	160000
1978	4682	17546	6638	28866	7027	6373	29623	43023	9213	12263	45194	66670	102377	36182	138559	135000
1979	9194	6537	8445	24176	21572	16890	27025	65487	14184	12693	50359	77236	130779	36120	166899	180000
1980	13592	7437	17210	38239	21920	6830	37015	65765	15523	13963	42298	71784	147558	28230	175788	180000
1981	22125	4760	14251	41136	23112	3847	23002	49961	21754	15070	42827	79651	147071	23677	170748	200000
1982	58384	8923	14429	81736	8881	4074	42141	55096	27181	9271	56490	92942	207506	22268	229774	230000
1983	37276	4158	10748	52182	31621	2815	40683	75119	39123	10920	55001	105044	214452	17893	232345	260000
1984	9231	2782	13150	25163	48114	11059	35143	94316	47668	15973	49351	112992	202657	29814	232471	266000
1985	1466	78	10211	11755	68880	12945	30368	112193	36863	31176	39306	107345	187094	44199	231293	266000
1986	5734	7859	12916	26509	62086	5781	28384	96251	57805	53946	32202	143953	199127	67586	266713	266000
1987	39344	3999	16022	59365	39686	6160	27442	73288	44612	25916	36743	107271	203849	36075	239924	256000
1988	41468	9	17112	58589	40260	50	33820	74130	57805	26748	51405	135958	241870	26807	268677	266000
1989	33626	1003	23304	57933	37350	1179	20711	59240	40958	36621	59238	136817	215187	38803	253990	235000
1990	17883	183	14505	32571	26920	504	27516	54940	31187	25488	75266	131941	193277	26175	219452	199262

cont'd

Table 1. (cont'd)

	2J				3K				3L				2J3KL			
	Offshore mobile gear		Fixed gear		Offshore mobile gear		Fixed gear		Offshore mobile gear		Fixed gear					
Year	Canada	Other	Canada	Total	Canada	Other	Canada	Total	Canada	Other	Canada	Total	Total Canada	Total Other	Total	TAC
1991	621	82	2214	2917	30112	311	13332	43755	30264	49660 [2]	45416 [3]	125340	121959	50053	172012	190000
1992	0	0	18	18	584	273	884	1741	13627	14610 [4]	10960 [5]	39197	26073	14883	40956	0
1993	0	0	13	13	0	0	541	541	2	2425 [6]	8411 [7]	10838	8967	2425	11392	0
1994	0	0	9	9	0	0	368	368	0	1	936	937	1313	1	1314 [8]	0
1995 [13]	0	0	0	1	0	0	122	122	1	0	290	290	413	0	413 [9]	0
1996 [13]	0	0	3	3	0	0	961	961	1	1	908	910	1874	1	1875 [10]	0
1997 [13]	0	0	4	4	0	0	280	280	0	0	592	593	877	0	877	0
1998 [13]	0	0	16	16	0	0	1994	1994	1	6	2491	2497	4501	0	4507	4000
1999 [13]	0	0	33	33	0	0	3554	3554	0	1	4938	4939	8525	1	8526	9000
2000 [1]	0	0	3	3	0	0	1410	1410	26	54 [12]	3937	4017	5376	54	5430	7000
2001 [1]	0	0	21	21	0	0	1736	1736	7	82 [12]	5124	5212	6887	82	6969	5600
2002 [1]	0	0	13	13	0	0	647	647	3	50 [12]	3533	3586	4196	50	4246	5600
2003 [1]	0	0	2	2	0	0	29	29	3	23 [12]	937 [11]	963	971	23	994	0
2004 [1]	0	0	3	3	0	0	152	152	6	0	482	488	643	0	643	0

[1] Provisional catches.

[2] Includes French catch and other foreign catch as estimated by Canadian surveillance.

[3] Figure is 4000 t less than Canadian statistics (this quantity is considered 3NO catch misreported as 3

[4] Derived from reported catch and Canadian surveillance estimate of foreign catch.

[5] Includes 5000 t catch from the recreational fishery after the moritorium was declared.

[6] Canadian surveillance estimate of foreign catch .

[7] Includes 5053 t estimated for the recreational fishery additional to that recorded by Canadian statistics.

[8] 1300 t is from the food fishery; the remainder is bycatch

[9] Includes 275 t caught in the sentinel survey and 138 t caught as bycatch.

[10] Comprised of a sentinel survey catch of 296 t, a food fishery catch of 1155 t and bycatch of 422 t.

[11] 780 t of this catch was the result of a mass mortality in Smith Sound

[12] NAFO Scientific Council agreed catches.

[13] Canadian catches have been updated based on most recent catch data

Table 2. Fixed gear landings (t) by Division and gear type in Divisions 2J, 3K and 3L in 1975-2004. Landings from statistical areas other than Newfoundland are not included.

	2J					3K					3L					2J3KL
Year	Trap	GN	LL	HL	Total	Trap	GN	LL	HL	Total	Trap	GN	LL	HL	Total	Total
1975	642	2304	0	54	3000	4662	8645	565	1646	15518	10390	7552	1641	3112	22695	41213
1976	1022	2787	6	36	3851	7056	10666	718	2439	20879	18404	9066	2904	4835	35209	59939
1977	1285	2076	37	125	3523	11501	11611	1294	4412	28818	20988	8852	3591	6851	40282	72623
1978	2872	3376	55	335	6638	11329	11445	3647	3202	29623	23218	9023	5114	7839	45194	81455
1979	1333	5663	175	1274	8445	3532	11474	8414	3605	27025	20785	13488	7022	9064	50359	85829
1980	4679	11414	204	913	17210	12732	13549	8059	2675	37015	12871	11231	9394	8802	42298	96523
1981	3893	10105	72	181	14251	3952	10679	6360	2011	23002	10177	13579	11425	7646	42827	80080
1982	4464	9121	114	730	14429	16415	17571	6101	2054	42141	24248	20295	5704	6243	56490	113060
1983	3870	4854	842	1182	10748	10490	18305	2560	9328	40683	25690	16446	3834	9031	55001	106432
1984	5618	6116	379	1037	13150	9957	14362	2499	8325	35143	23103	14985	3824	7439	49351	97644
1985	4973	2992	252	1994	10211	13310	8082	2352	6624	30368	21594	8760	3245	5707	39306	79885
1986	4373	7804	109	630	12916	14555	7626	1555	4648	28384	15669	9865	2492	4176	32202	73502
1987	5158	9228	218	1418	16022	11278	10223	1590	4351	27442	11370	17419	3338	4616	36743	80207
1988	5907	9183	272	1750	17112	16261	11898	935	4726	33820	22148	18576	4004	6677	51405	102337
1989	6713	14846	290	1455	23304	8189	7921	700	3901	20711	23964	22231	4676	8367	59238	103253
1990	3616	9364	653	872	14505	11201	7726	3838	4751	27516	32158	28936	4545	9627	75266	117287
1991	1016	271	93	834	2214	7696	1384	1851	2401	13332	26524	11696 [2]	1247	5949	45416 [2]	60962
1992	0	0	2	16	18	27	103	9	745	884	1173	1131	16	8640 [3]	10960 [3]	11862
1993	0	0	1	12	13	3	37	9	492	541	11	93	80	8227 [3]	8411 [3]	8965
1994	0	0	0	9	9	0	8	0	359	367	6	38	22	870	936	1312
1995	0	0	0	0	0	25	65	31	1	122	23	207	41	20	291	413
1996	0	0	0	3	3	65	184	31	680	959	42	335	30	501	656	1870
1997	0	2	0	0	2	57	150	63	8	278	71	427	42	45	585	865
1998	0	3	5	8	16	24	1081	245	644	1994	31	1377	284	798	2490	4501
1999 [1]	0	20	4	9	33	14	3080	110	350	3554	35	4469	70	365	4938	8525
2000 [1]	0	4	0	1	5	15	1126	43	275	1459	63	2954	189	684	3891	5354
2001 [1]	0	3	1	17	21	28	796	90	822	1735	175	2844	110	1994	5124	6880
2002 [1]	0	7	0	6	13	2	272	30	342	647	128	2517	30	858	3533	4193
2003 [1]	0	2	0	0	2	0	25	4	0	29	0	152	4	781	937	968
2004 [1]	0	1	0	0	1	0	146	5	0	152	0	479	2	0	481	635

[1] Provisional catches.

[2] Catch is 4000 (t) less than Canadian statistics as this quantity is considered 3NO gillnet catch misreported in 3L.

[3] Estimate for recreational fishery has been reported as 3L Handline.

[4] Comprised of sentinel survey catch of 294 t, a food fishery catch of 1155 t and by-catch 142 t.
An amount of 103 t must still be allocated by gear type and division from the sentinel catches.

[5] 780t of this catch was the result of a mass mortality in Smith Sound. (Actual gear used was gaff or dip net).

Table 3. Fixed gear landings in Div. 3L, by broad area (inshore vs offshore) and gear (gillnet vs other). The numbers do not match those in Table 2 because they are extracted from a different statistical source. (from Shelton et al. 1996)

	Inshore		Offshore	
	Gillnet	Other	Gillnet	Other
1975	7,440	14,908	0	0
1976	9,012	26,141	8	0
1977	8,768	31,433	46	0
1978	9,024	36,237	0	18
1979	13,486	36,876	1	32
1980	11,228	31,061	0	9
1981	12,117	29,243	1,630	3
1982	20,274	36,184	1,049	0
1983	16,451	38,557	0	1,148
1984	14,947	34,121	808	898
1985	8,753	29,688	1,590	856
1986	8,277	21,953	1,652	387
1987	11,660	17,946	5,752	194
1988	9,143	30,648	9,422	887
1989	8,329	34,682	13,890	558
1990	7,174	43,841	21,721	157
1991	2,219	33,657	9,499	2

Table 4a. Catch (t) in 2003 from all sources (by-catch, sentinel surveys and mass mortality), by gear, unit area and month. The 780 t in 3Lb in April is recorded as taken by handline, but this is the quantity of fish obtained from the mass mortality in Smith Sound. It was taken by gaff or dipnet.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gillnet													
2JM							0.02	0.53	0.24				0.79
3KA							1.27	0.94	0.12				2.33
3KD						0.01	0.49	1.07	0.51	0.98			3.06
3KH						0.11	0.98	1.61	0.89	0.56	0.43		4.58
3KI						1.97	2.45	5.03	0.23	0.43	1.31		11.42
3LA						1.16	41.67	11.09	0.48		2.62		57.01
3LB						3.78	32.16	7.84	9.25	0.10	1.73		54.87
3LD							0.44						0.44
3LF						0.30	2.59	7.26	2.46				12.61
3LJ						0.20	3.33	2.26	0.18				5.96
3LQ						4.16	7.26	4.62					16.04
Total						11.69	92.64	42.25	14.36	2.07	6.08		169.11
Gillnet (small mesh)													
2JM							0.04	0.40	0.52				0.96
3KA							0.01	0.40	0.12				0.52
3KD						0.00	0.08	0.28	0.31	0.13			0.80
3KH							0.20	0.29	0.05	0.16	0.21		0.91
3KI						0.05	0.27	0.25	0.05	0.16	0.35	0.16	1.28
3LA							0.25	0.56	0.28		0.29		1.37
3LB						0.06	0.35	0.94	0.72	0.01	0.18		2.25
3LF						0.00	0.28	0.20	0.06				0.54
3LJ						0.01	0.12	0.06					0.19
3LQ						0.01	0.08	0.17					0.26
Total						0.13	1.68	3.54	2.10	0.46	1.02	0.16	9.08
Linetrawl													
3KH								0.01	1.73	0.24			1.97
3KI								0.32	1.02	0.30	0.12		1.75
3LA								0.70	0.39				1.09
3LF									0.11	0.15			0.26
3LJ								0.22			2.29		2.51
3LQ								0.08	0.40	0.01			0.49
Total								1.32	3.65	0.69	2.41		8.08
Handline													
2JM									0.10				0.10
3KH									0.34				0.34
3KI											0.06		0.06
3LA				0.50									0.50
3LB				780.33	0.02								780.35
3LQ											0.22		0.22
Total				780.82	0.02				0.43		0.29		781.57
Otter trawl													
3KG					0.00								0.00
3LC										0.01			0.01
3LD						0.00				0.02			0.02
3LG										0.01			0.01
3LH										0.01			0.01
3LI										0.00			0.00
3LQ										0.01			0.01
3LR					0.00			1.08		0.57			1.65
3LS							0.10	0.70		0.46			1.26
Total					0.00	0.00	0.10	1.78		1.09			2.97
All gears	0.00	0.00	0.00	780.82	0.03	11.82	94.42	48.90	20.54	4.31	9.80	0.16	970.79

Table 4b. Catch (t) in 2004 from all sources (by-catch and sentinel surveys), by gear, unit area and month.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gillnet													
2Jm							0.06	0.68	0.43				1.17
3Ka							0.08	0.51	0.05				0.64
3Kb							0.16	0.22					0.38
3Kc							0.05						0.05
3Kd							0.67	1.75	0.45	0.08	0.10		3.05
3Kf								0.46	0.07				0.54
3Kg								0.02					0.02
3Kh						0.10	9.16	11.08	1.16	0.81	0.18	0.04	22.53
3Ki						3.14	36.87	72.09	0.57	0.60	2.68		115.96
3La						6.43	89.87	59.63	0.61		2.32		158.86
3Lb						17.80	51.89	60.68	4.71		2.03		137.10
3Lc								0.10	1.19	0.10			1.39
3Ld								0.05	0.32	0.49	0.15		1.01
3Lf						0.95	29.36	36.99	1.47				68.78
3Lj						3.10	32.40	49.25	1.06				85.82
3Lq						4.32	8.38	8.63	0.01				21.33
Total						35.84	258.96	302.14	12.10	2.08	7.45	0.04	618.61
Gillnet (small mesh)													
2Jm							0.22	0.54	0.54				1.31
3Ka							0.02	0.31	0.05				0.38
3Kd							0.09	0.28	0.11	0.01	0.00		0.50
3Kh							0.17	0.24	0.03	0.12	0.00		0.57
3Ki						0.14	0.41	0.33	0.03	0.13	0.34	0.50	1.87
3La						0.01	0.34	0.66	0.03		0.13		1.17
3Lb						0.12	0.49	1.00	0.58		0.35		2.55
3Lf						0.41	0.11	0.12	0.18				0.83
3Lj						0.00	0.15	0.10					0.25
3Lq						0.02	0.11	0.05					0.17
Total						0.70	2.12	3.63	1.55	0.26	0.82	0.50	9.59
Linetrawl													
3Kh								0.19	1.64	0.15			1.98
3Ki								0.16	1.32	0.38		0.11	1.96
3La								0.62	0.32				0.95
3Lf									0.35	0.42	0.05		0.81
3Lq								1.24		0.07			1.30
3Lt				0.01									0.01
Total				0.01				2.22	3.63	1.01	0.05	0.11	7.02
Handline													
3Kh									0.44				0.44
Total									0.44				0.44
Otter trawl													
3Kf									0.75	0.09			0.84
3Kg										0.01			0.01
3Lg							0.24						0.24
3Lr						5.30	0.51						5.81
Total						5.30	0.75		0.75	0.10			6.90
All gears	0.00	0.00	0.00	0.01	0.00	41.84	261.83	308.00	18.46	3.46	8.32	0.65	642.55

Table 5a. Number of fish measured in 2003 from all sources (by-catch, sentinel surveys and mass mortality), by gear, unit area and month. The sampling in 3Lb in April is recorded as taken by handline, but it is from the fish obtained during the mass mortality in Smith Sound. It was taken by gaff or dipnet.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gillnet													
2JM							8	299	137				444
3KA							31	440	77				548
3KD						6	231	463	247	113			1060
3KH						50	479	762	414	299	398		2402
3KI						207	1122	998	96	177	589		3189
3LA							1414	1617	214		867		4112
3LB						627	3401	2759	1619	40	558		9004
3LF						79	1051	1978	344				3452
3LJ						73	1524	958	86				2641
3LQ						836	3088	2058					5982
Total						1878	12349	12332	3234	629	2412		32834
Gillnet-small mesh													
2JM							48	569	786				1403
3KA							16	681	180				877
3KD						2	104	366	450	221			1143
3KH							382	569	73	266	334		1624
3KI						63	385	451	59	282	523	243	2006
3LA							409	955	431		340		2135
3LB						78	394	1231	1030	10	105		2848
3LF						4	408	365	86				863
3LJ						28	231	97					356
3LQ						9	81	270					360
Total						184	2458	5554	3095	779	1302	243	13615
Linetrawl													
3KH								9	1758	262			2029
3KI								291	883	292	126		1592
3LA								636	448				1084
3LF									108	132			240
3LJ								147					147
3LQ								27	206	4			237
Total								1110	3403	690	126		5329
Handline													
2JM									109				109
3KH									317				317
3LB				**395**									395
Total				395					426				821
All gears	0	0	0	395	0	2062	14807	18996	10158	2098	3840	243	52599

Table 5b. Number of fish measured in 2004 from all sources (by-catch and sentinel surveys), by gear, unit area and month.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Gillnet													
2JM							29	357	227				613
3KA							44	300	26				370
3KD							305	698	196	34	45		1278
3KF								136	3				139
3KH						32	928	1679	584	424	89		3736
3KI						1228	3218	4210	250	301	1392		10599
3LA						85	3160	2398	123		806		6572
3LB						884	2806	2783	1792		710		8975
3LC								68	66				134
3LF						420	2723	1874	642				5659
3LJ						1277	3256	3126	487				8146
3LQ						715	3607	2040	3				6365
Total	0	0	0	0	0	4641	20076	19669	4399	759	3042	0	52586
Gillnet- small mesh													
2JM							345	799	760				1904
3KA							33	424	70				527
3KD							128	415	155	14	3		715
3KH							249	367	34	110	7		767
3KI						170	555	435	24	192	419	70	1865
3LA						8	484	902	27		91		1512
3LB						89	575	1001	520		196		2381
3LF						53	127	112	233				525
3LJ						3	179	84					266
3LQ						17	116	64					197
Total	0	0	0	0	0	340	2791	4603	1823	316	716	70	10659
Linetrawl													
3KH						188	1393	149					1730
3KI						140	1123	317					1580
3LA						565	306						871
3LF							265	351	34				650
3LQ						552		34					586
Total	0	0	0	0	0	1445	3087	851	34	0	0	0	5417
Handline													
3KH							354						354
Total	0	0	0	0	0	0	354	0	0	0	0	0	354
Ottertrawl													
3KF							150						150
Total	0	0	0	0	0	0	150	0	0	0	0	0	150
Twin trawl													
2JB	5	12								8			25
2JC		14	2										16
2JF	2			16					16				34
2JN	4	23											27
3KC			53	36									89
3LE				4									4
3LI				4	13								17
Total	11	49	55	60	13	0	0	0	16	8	0	0	212
Shrimp Trawl													
2JB		10											10
2JC		19	4	14									37
2JF			4	3									7
2JN		16	59										75
3KC		22	36	10			6	11					85
3KF							48	7					55
3KG		48	69				3						120
3LE	2												2
Total	2	115	172	27	0	0	57	18	0	0	0	0	391
All gears	13	164	227	87	13	6426	26515	25141	6272	1083	3758	70	69769

Table 6a. Number of fish aged in 2003 from all sources (by-catch, sentinel surveys and mass mortality), by gear, unit area and month. Quarter 1 is January-February, Quarter 2 is March-May, Quarter 3 is June-August and Quarter 4 is September-December.The sample of 171 in 3Lb in Quarter 2 is recorded as taken by handline, but it is from the fish obtained during the mass mortality in Smith Sound. It was taken by gaff or dipnet.

	Quarter				
	1	2	3	4	Total
Gillnets					
2JM			244		244
3KA			38		38
3KD		8	262	32	302
3KH		15	443	83	541
3KI		58	283	95	436
3LA			263	64	327
3LB		37	942	54	1033
3LF		43	376	8	427
3LJ		21	95		116
3LQ		75	167		242
Total		257	3113	336	3706
Linetrawl					
3KH			154	11	165
3KI			35	22	57
3LA			31		31
3LF			35	21	56
3LQ			25		25
			280	54	334
Handline					
3LJ			7		7
3LB		171			171
Total		171	7		178
All gears	0	428	3400	390	4218

Table 6b. Number of fish aged in 2004 from all sources (by-catch and sentinel surveys), by gear, unit area and month. Quarter 1 is January-February, Quarter 2 is March-May, Quarter 3 is June-August and Quarter 4 is September-December.

	Quarter				
	1	2	3	4	Total
Gillnets					
2JM			296		296
3KA			42		42
3KD			230	85	315
3KF			49		49
3KH			468	56	524
3KI			609	41	650
3LA			563	102	665
3LB			679	171	850
3LF			418	65	483
3LJ			412	30	442
3LQ		3	245		248
Total	0	3	4011	550	4564
Linetrawl					
3KH				57	57
3KI				25	25
3LA				35	35
3LF				65	65
	0	0	0	182	182
Handline					
2JM		2			2
	0	2	0	0	2
Ottertrawl					
3KF			42		42
Total	0	0	42	0	42
Twin trawls					
2JB	6	1		8	15
2JF	2		19		21
3KC	53	32	4		89
3LE		3			3
3LI		17			17
Total	61	53	23	8	145
Shrimp trawl					
2JB	5	3			8
2JC	11	14			25
2JF	3	3			6
2JN	42				42
3KB	1				1
3KC	66	9	11		86
3KF			52		52
3KG	110				110
3LE	2	2			4
3LI		1			1
Total	240	32	63	0	335
All gears	301	90	4139	740	5270

Table 7a. Estimated average weight (kg), length (cm) and number (plus standard error and coefficient of variation) of the 2004 catch at age, for all gears combined and for gillnet and linetrawl separately.

	WEIGHT	LENGTH		NUMBER		
AGE	(kg.)	(cm.)		(000'S)	STD ERR.	CV
Total stock area; all gears combined						
1	0.00	0.00	0.00	0.0	0.00	
2	0.33	34.07	0.29	0.9	0.34	0.39
3	0.56	39.88	5.75	10.3	1.17	0.11
4	0.87	45.82	20.54	23.7	1.43	0.06
5	1.54	55.40	51.41	33.4	1.17	0.03
6	2.12	61.70	100.62	47.4	1.25	0.03
7	2.73	66.83	162.45	59.5	1.52	0.03
8	3.33	71.24	105.67	31.7	1.18	0.04
9	4.18	76.69	58.78	14.1	0.78	0.06
10	5.02	81.44	35.08	7.0	0.57	0.08
11	5.46	83.56	15.69	2.9	0.35	0.12
12	6.34	87.77	33.50	5.3	0.47	0.09
13	6.26	87.22	13.39	2.1	0.29	0.14
14	6.56	88.87	12.79	2.0	0.26	0.13
15	6.81	90.36	2.33	0.3	0.12	0.36
Total				240.6		
Total stock area; gillnet						
1	0.00	0.00	0.00	0.0	0.00	
2	0.33	34.06	0.28	0.8	0.35	
3	0.53	39.40	4.61	8.6	1.18	0.14
4	0.86	45.65	17.26	20.1	1.44	0.07
5	1.56	55.68	46.82	30.0	1.16	0.04
6	2.13	61.80	98.01	45.9	1.26	0.03
7	2.74	66.87	161.56	59.0	1.54	0.03
8	3.34	71.33	104.74	31.3	1.20	0.04
9	4.18	76.70	58.42	14.0	0.79	0.06
10	5.02	81.43	34.94	7.0	0.58	0.08
11	5.45	83.57	15.72	2.9	0.36	0.12
12	6.32	87.67	33.01	5.2	0.47	0.09
13	6.26	87.22	13.57	2.2	0.30	0.14
14	6.56	88.86	12.92	2.0	0.26	0.13
15	6.81	90.36	2.36	0.3	0.12	0.36
Total				229.3		
Total stock area; linetrawl						
1	0.00	0.00	0.00	0.0	0.00	
2	0.33	33.76	0.01	0.0	0.01	
3	0.75	44.00	0.76	1.0	0.13	0.12
4	0.93	47.25	1.79	1.9	0.14	0.07
5	1.37	53.50	1.84	1.3	0.15	0.11
6	1.86	59.27	1.30	0.7	0.09	0.13
7	2.34	63.58	0.55	0.2	0.03	0.11
8	2.93	68.40	0.31	0.1	0.01	0.11
9	3.64	73.45	0.10	0.0	0.01	0.19
10	4.63	79.42	0.06	0.0	0.00	0.28
11	4.05	74.48	0.01	0.0	0.00	0.63
12	7.46	92.49	0.06	0.0	0.00	0.31
13	7.62	94.00	0.00	0.0	0.00	1.19
14	0.00	0.00	0.00	0.0	0.00	
15	0.00	0.00	0.00	0.0	0.00	
Total				5.4		

Table 7b. Estimated average weight (kg), length (cm) and number (plus standard error and coefficient of variation) of the 2004 catch at age, all gears combined, for the total stock area, for the central portion of the inshore, and for the southern portion of the inshore.

	WEIGHT	LENGTH		NUMBER		
AGE	(kg.)	(cm.)		(000'S)	STD ERR.	CV
Total stock area; all gears combined						
1	0.00	0.00	0.00	0.0	0.00	
2	0.33	34.07	0.29	0.9	0.34	0.39
3	0.56	39.88	5.75	10.3	1.17	0.11
4	0.87	45.82	20.54	23.7	1.43	0.06
5	1.54	55.40	51.41	33.4	1.17	0.03
6	2.12	61.70	100.62	47.4	1.25	0.03
7	2.73	66.83	162.45	59.5	1.52	0.03
8	3.33	71.24	105.67	31.7	1.18	0.04
9	4.18	76.69	58.78	14.1	0.78	0.06
10	5.02	81.44	35.08	7.0	0.57	0.08
11	5.46	83.56	15.69	2.9	0.35	0.12
12	6.34	87.77	33.50	5.3	0.47	0.09
13	6.26	87.22	13.39	2.1	0.29	0.14
14	6.56	88.87	12.79	2.0	0.26	0.13
15	6.81	90.36	2.33	0.3	0.12	0.36
Total				240.6		
Inshore central area; all gears combined						
1	0.00	0.00	0.00	0.0	0.00	
2	0.34	34.08	0.29	0.9	0.34	0.39
3	0.55	39.72	4.98	9.0	1.16	0.13
4	0.86	45.80	15.36	17.8	1.40	0.08
5	1.57	55.82	35.55	22.6	1.04	0.05
6	2.18	62.23	66.13	30.3	1.05	0.03
7	2.95	68.64	99.50	33.7	1.31	0.04
8	3.53	72.71	76.77	21.8	1.05	0.05
9	4.35	77.85	43.20	9.9	0.69	0.07
10	4.96	81.14	25.48	5.1	0.50	0.10
11	5.40	83.59	13.01	2.4	0.32	0.13
12	6.10	86.79	22.85	3.7	0.40	0.11
13	6.09	86.47	12.19	2.0	0.29	0.14
14	6.37	88.20	11.80	1.9	0.26	0.14
15	6.80	90.31	2.30	0.3	0.12	0.36
Total				161.5		
Inshore southern area; all gears combined						
1	0.00	0.00	0.00	0.0	0.00	
2	0.00	0.00	0.00	0.0	0.00	
3	0.61	41.23	0.57	0.9	0.16	0.17
4	0.96	47.15	3.49	3.6	0.30	0.08
5	1.51	55.10	13.22	8.7	0.51	0.06
6	2.03	60.87	32.15	15.8	0.68	0.04
7	2.44	64.46	60.94	25.0	0.78	0.03
8	2.91	68.15	27.23	9.4	0.56	0.06
9	3.75	73.81	14.75	3.9	0.37	0.09
10	5.18	82.27	9.19	1.8	0.28	0.16
11	5.72	83.37	2.60	0.5	0.14	0.32
12	6.91	89.97	9.92	1.4	0.25	0.17
13	8.59	97.38	1.26	0.1	0.06	0.43
14	9.82	100.78	1.01	0.1	0.01	0.11
15	7.62	94.00	0.03	0.0	0.00	0.69
Total				71.3		

Table 8. Catch numbers (thousands) at age for cod in 2J3KL in 1962-2004. Note that much of the "catch" in 2003 came from a mass mortality of cod in Smith Sound, Trinity Bay.

Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
2	301	1446	2872	85	819	790	288	59	6819	33	236	0	473	420	15
3	8666	5746	19338	5177	14057	15262	6142	4330	18104	12876	6737	3963	3231	3968	13767
4	26194	27577	27603	28709	65992	77873	94291	39626	60102	71557	79809	40785	13201	14101	33727
5	64337	60234	57757	46800	93687	100339	205805	100858	82357	95384	116562	94844	34927	25370	28049
6	58163	118112	60681	66946	62812	96759	150541	163228	101249	98111	76196	59503	74403	34426	20898
7	47314	58996	100147	64360	59312	54996	83808	107509	85696	57865	55984	35464	60539	39105	16811
8	27521	29349	50865	68176	30423	38691	39443	52661	29218	25055	29553	27351	35687	36485	16022
9	20142	15520	20892	33819	23844	17146	23171	19651	10857	11732	11750	14153	18854	13421	10931
10	18036	11612	12264	14913	8762	16084	10984	12370	3825	4470	6393	7566	10492	7514	4637
11	10444	8248	8698	6945	4528	5949	5591	6389	2000	2223	2987	3815	5818	2315	1462
12	9468	4204	6352	3729	2280	3367	5249	4479	1200	1287	1660	2153	2934	1179	631
13	7778	3942	4989	3948	1825	2108	1939	3004	507	1140	1388	1173	1078	808	292
14	5785	2933	4036	3730	1186	1529	1334	1557	224	720	725	450	652	372	251
15	4669	2928	2703	2722	967	685	818	622	214	355	748	278	249	165	100
16	3888	1737	1456	1859	806	424	610	567	244	474	606	309	338	82	50
17	3955	1263	1918	575	416	193	127	319	124	124	452	85	162	5	40
18	2161	1352	1154	971	279	107	89	100	32	128	136	27	113	8	64
19	232	328	501	183	486	72	83	46	10	148	195	38	45	22	30
20	403	182	312	226	178	211	26	99	34	78	36	8	20	1	20
Total	319457	355709	384538	353873	372659	432585	630339	517474	402816	383760	392153	291965	263216	179767	147797

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	108	0	0	92	0	0	16	3	0	1	42	25	8	58	35
3	7128	1323	1152	2554	2185	1702	2585	782	650	831	2329	2779	1696	7693	3111
4	65510	17556	12361	12025	7172	31286	13616	14871	14824	15219	9217	14651	17639	40557	31654
5	40462	39206	37493	28814	13191	19003	42602	31760	36614	44168	32340	20184	21150	36410	53805
6	12107	20319	29202	30016	24800	14397	19028	38624	33922	45869	49061	47917	25212	22695	29553
7	5397	7711	10982	18017	22014	25435	12044	12503	28006	26025	28469	45725	38708	16390	9064
8	3396	3078	3460	4830	11848	16930	14701	7246	7050	14722	19505	18608	28499	17940	6164
9	2730	1530	1300	1217	3175	11936	8934	8910	3836	3104	5818	9026	8696	9156	4745
10	1381	1083	757	520	779	1923	6341	4227	5162	2000	1346	4337	3640	2865	1696
11	532	437	560	232	309	338	1018	2536	2905	1977	676	774	1695	1084	641
12	296	219	183	229	195	156	248	451	1681	1101	873	422	572	478	250
13	149	105	116	56	125	90	90	146	254	574	391	366	244	103	88
14	75	62	51	65	48	153	41	48	107	116	200	223	180	98	39
15	42	40	43	37	14	40	29	41	39	29	37	100	94	36	21
16	21	21	38	13	28	12	11	30	20	18	22	32	43	25	9
17	20	7	7	10	20	13	9	7	17	11	3	5	4	8	3
18	14	8	7	14	5	4	6	7	1	9	1	10	9	7	2
19	2	2	4	4	5	0	2	4	3	2	4	5	0	1	2
20	6	7	9	10	5	0	3	3	5	2	0	5	1	0	0
Total	139376	92714	97725	98755	85918	123418	121326	122199	135096	155778	150334	165194	148090	155604	140882

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0	0	0	0	1	0	3	7	5	10	6	0.2	0.9
3	430	940	105	12	35	12	96	70	141	249	166	9.4	10.3
4	3860	4993	379	41	157	39	229	238	258	778	296	11.1	23.7
5	14535	3343	575	93	304	92	395	638	419	710	399	18.6	33.4
6	12211	1940	177	76	401	95	689	795	437	611	335	53.4	47.4
7	4526	700	74	25	131	148	384	1157	328	365	235	44.1	59.5
8	1372	147	22	10	24	35	236	370	294	190	124	27.7	31.7
9	376	21	2	2	7	5	74	253	151	272	77	22.3	14.1
10	199	0	0	0	2	2	10	52	136	80	113	9.5	7.0
11	104	0	0	0	0	0	5	13	33	117	50	32.3	2.9
12	18	0	0	0	0	0	2	3	5	33	52	20.3	5.3
13	9	0	0	0	0	0	1	0	3	3	10	26.8	2.1
14	4	0	0	0	0	0	0	0	1	1	2	6.7	2.0
15	0	0	0	0	0	0	0	0	0	0	0	3.0	0.3
16	0	0	0	0	0	0	0	0	0	0	0	0.0	0
17	0	0	0	0	0	0	0	0	0	0	0	0.0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
												0	0
Total	37644	12084	1334	259	1062	429	2125	3596	2210	3418	1866	286	241

Table 9. Catch weights-at-age (kg) for cod caught in 2J3KL in 1962-2004.

Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
2	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14		0.11	0.26	0.25
3	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.44	0.32	0.35	0.45	0.45
4	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.53	0.47	0.68	0.63	0.61
5	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.64	0.71	0.91	0.96	0.93
6	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.08	0.96	1.11	1.18	1.32
7	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.52	1.30	1.27	1.39	1.75
8	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.12	2.13	1.80	1.56	1.74	2.07
9	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.86	2.20	2.05	2.21	2.24
10	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.18	3.29	2.82	2.75	2.61	2.99
11	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.76	3.95	3.19	3.13	3.34	3.67
12	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.15	4.12	3.79	3.41	3.66	4.56
13	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	6.06	5.00	4.53	4.92	4.78	6.18
14	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	5.54	9.32	6.93	4.40	5.20	8.19
15	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	6.11	9.40	7.22	6.33	5.20	9.77
16	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	6.89	7.05	5.50	5.46	11.23
17	6.44	6.44	6.44	6.44	6.44	6.44	6.44	6.44	6.44	6.44	14.67	9.45	7.57	8.51	12.44
18	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	6.07	12.04	11.16	11.07	9.24	11.16
19	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	6.61	7.62	7.62	7.62	7.62	7.62
20	7.19	7.19	7.19	7.19	7.19	7.19	7.19	7.19	7.19	7.19	17.46	17.46	17.46	17.46	17.46

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	0.09			0.41	0.00		0.31	0.34		0.21	0.32	0.29	0.26	0.29	0.17
3	0.45	0.40	0.46	0.53	0.55	0.53	0.62	0.59	0.48	0.51	0.43	0.49	0.48	0.42	0.36
4	0.60	0.72	0.74	0.77	0.78	0.84	0.87	0.88	0.73	0.72	0.66	0.73	0.74	0.69	0.61
5	0.97	1.04	1.13	1.16	1.17	1.20	1.32	1.20	1.10	1.04	1.03	1.08	1.03	1.06	0.97
6	1.66	1.58	1.67	1.71	1.64	1.77	1.75	1.79	1.43	1.54	1.32	1.38	1.44	1.50	1.41
7	2.33	2.46	2.46	2.38	2.23	2.10	2.28	2.28	2.06	1.85	1.87	1.67	1.83	1.94	1.88
8	2.82	3.26	3.57	3.56	2.86	2.66	2.61	2.71	2.66	2.35	1.93	2.21	2.07	2.22	2.27
9	3.46	4.05	4.41	5.01	3.81	3.09	3.18	2.96	3.23	2.94	2.80	2.51	2.64	2.44	2.63
10	3.88	4.46	5.25	5.49	5.32	4.18	3.50	3.65	3.32	3.47	3.51	3.04	3.02	3.06	3.14
11	4.78	5.02	5.80	6.72	6.29	6.16	4.79	4.28	4.06	3.80	4.80	4.37	3.96	3.58	3.80
12	6.13	6.72	7.03	7.87	7.06	7.19	7.76	6.19	4.55	4.54	4.64	5.49	5.41	4.68	4.96
13	7.31	8.10	8.96	8.38	7.32	8.00	9.07	8.39	7.03	5.34	5.74	6.55	7.50	6.23	5.49
14	8.40	7.42	8.54	10.03	10.01	8.36	9.14	10.26	9.67	7.12	6.13	8.60	9.24	8.51	7.61
15	8.81	8.20	9.46	11.31	8.99	7.86	10.62	11.44	11.37	11.77	8.53	9.76	10.05	9.78	11.58
16	11.75	11.26	10.70	13.87	11.54	7.91	10.57	11.61	11.27	11.24	13.51	9.73	9.34	12.58	11.01
17	10.63	11.61	13.12	10.68	10.48	9.58	13.13	17.47	12.68	14.15	9.10	12.58	15.74	15.45	12.82
18	12.27	8.92	13.49	16.09	11.15	12.95	15.97	12.94	12.42	16.14	21.77	16.01	18.66	13.58	13.00
19	7.62	10.57	15.51	12.04	9.82	0.00	9.73	15.21	14.38	12.30	17.66	16.60		17.26	13.10
20	17.46	16.00	14.77	11.37	12.59	0.00	15.88	12.81	19.49	15.72	0.00	11.03	17.64		

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2				0.22	0.37	0.32	0.29	0.32	0.26	0.38	0.41	0.31	0.33
3	0.29	0.57	0.40	0.49	0.70	0.54	0.63	0.59	0.66	0.63	0.63	0.50	0.56
4	0.58	0.71	0.68	0.80	1.01	0.88	0.94	1.05	0.97	0.91	0.91	0.82	0.87
5	0.81	0.97	0.98	1.47	1.42	1.46	1.51	1.62	1.71	1.36	1.56	1.41	1.54
6	1.19	1.25	1.41	1.91	2.04	1.98	2.14	2.12	2.14	2.02	2.09	2.03	2.12
7	1.73	1.59	1.85	2.27	2.51	2.44	2.48	2.51	2.79	2.54	2.70	2.54	2.73
8	2.05	8.40	2.05	2.62	2.77	2.91	3.02	2.96	3.39	3.24	3.24	3.03	3.33
9	2.66	9.23	3.05	3.02	3.22	3.63	3.35	3.66	3.95	3.93	3.83	3.64	4.18
10	2.24			2.81	3.87	4.25	4.18	4.70	4.54	4.43	4.45	4.36	5.02
11	2.68			4.67	5.18	4.36	4.01	5.17	4.88	5.06	4.77	4.91	5.46
12	4.95			0.00	4.04	6.06	3.80	5.57	6.03	6.56	5.13	5.72	6.34
13	5.34			0.00	7.62	6.22	6.42	6.23	5.63	7.21	5.90	5.92	6.26
14	7.02			0.00	4.46	0.00	0	7.66	4.80	5.46	5.70	6.07	6.56
15				0.00	0.00		0		9.42	7.62	6.10	5.38	6.81
16										0.00	0.00	0.00	
17									11.28	0.00	0.00	6.90	
18										0	8.40		
19										0			
20													

Table 10. Catch biomass (t) at age for cod caught in 2J3KL in 1962-2004.

Age	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
2	42	202	402	12	115	111	40	8	955	5	33	0	52	109	4
3	2946	1954	6575	1760	4779	5189	2088	1472	6155	4378	2964	1268	1131	1786	6195
4	14407	15167	15182	15790	36296	42830	51860	21794	33056	39356	42299	19169	8977	8884	20573
5	56617	53006	50826	41184	82445	88298	181108	88755	72474	83938	74600	67339	31784	24355	26086
6	71540	145278	74638	82344	77259	119014	185165	200770	124536	120677	82292	57123	82587	40623	27585
7	78541	97933	166244	106838	98458	91293	139121	178465	142255	96056	85096	46103	76885	54356	29419
8	58345	62220	107834	144533	64497	82025	83619	111641	61942	53117	62948	49232	55672	63484	33166
9	53175	40973	55155	89282	62948	45265	61171	51879	28662	30972	33605	31137	38651	29660	24485
10	57354	36926	39000	47423	27863	51147	34929	39337	12164	14215	21033	21336	28853	19612	13865
11	39269	31012	32704	26113	17025	22368	21022	24023	7520	8358	11799	12170	18210	7732	5366
12	39292	17447	26361	15475	9462	13973	21783	18588	4980	5341	6839	8160	10005	4315	2877
13	47135	23889	30233	23925	11060	12774	11750	18204	3072	6908	6940	5314	5304	3862	1805
14	32049	16249	22359	20664	6570	8471	7390	8626	1241	3989	6757	3119	2869	1934	2056
15	28528	17890	16515	16631	5908	4185	4998	3800	1308	2169	7031	2007	1576	858	977
16	22667	10127	8488	10838	4699	2472	3556	3306	1423	2763	4175	2178	1859	448	562
17	25470	8134	12352	3703	2679	1243	818	2054	799	799	6631	803	1226	43	498
18	13117	8207	7005	5894	1694	649	540	607	194	777	1637	301	1251	74	714
19	1534	2168	3312	1210	3212	476	549	304	66	978	1486	290	343	168	229
20	2898	1309	2243	1625	1280	1517	187	712	244	561	629	140	349	17	349
Total	644926	590090	677428	655244	518248	593302	811698	774346	503047	475357	458793	327188	367583	262319	196809

Age	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
2	10	0	0	38	0	0	6	1	0	0	13	7	2	17	6
3	3208	529	530	1354	1202	902	1603	461	312	424	1001	1362	814	3231	1120
4	39306	12640	9147	9259	5594	26280	11846	13086	10822	10958	6083	10695	13053	27984	19309
5	39248	40774	42367	33424	15433	22804	56235	38112	40275	45935	33310	21799	21785	38595	52191
6	20098	32104	48767	51327	40672	25483	33299	69137	48508	70638	64761	66125	36305	34043	41670
7	12575	18969	27016	42880	49091	53414	27460	28507	57692	48146	53237	76361	70836	31797	17040
8	9577	10034	12352	17195	33885	45034	38370	19637	18753	34597	37645	41124	58993	39827	13992
9	9446	6197	5733	6097	12097	36882	28410	26374	12390	9126	16290	22655	22957	22341	12479
10	5358	4830	3974	2855	4144	8038	22194	15429	17138	6940	4724	13184	10993	8767	5325
11	2543	2194	3248	1559	1944	2082	4876	10854	11794	7513	3245	3382	6712	3881	2436
12	1814	1472	1286	1802	1377	1122	1924	2792	7649	4999	4051	2317	3095	2237	1240
13	1089	851	1039	469	915	720	816	1225	1786	3065	2244	2397	1830	642	483
14	630	460	436	652	480	1279	375	492	1035	826	1226	1918	1663	834	297
15	370	328	407	418	126	314	308	469	443	341	316	976	945	352	243
16	247	236	407	180	323	95	116	348	225	202	297	311	402	315	99
17	213	81	92	107	210	125	118	122	216	156	27	63	63	124	38
18	172	71	94	225	56	52	96	91	12	145	22	160	168	95	26
19	15	21	62	48	49	0	19	61	43	25	71	83	0	17	26
20	105	112	133	114	63	0	48	38	97	31	0	55	18	0	0
Total	146023	131904	157091	170005	167661	224625	228118	227236	229191	244066	228564	264975	250632	215096	168021

Age	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0	0	0	0	0	0	1	2	1	4	3	0	0
3	125	536	42	6	25	6	60	41	93	157	104	5	6
4	2239	3545	258	32	158	34	214	249	249	704	268	9	21
5	11773	3243	564	138	433	134	596	1032	716	967	623	26	51
6	14531	2425	250	144	817	189	1478	1687	936	1232	702	109	101
7	7830	1113	137	57	329	361	954	2908	915	926	635	112	162
8	2813	1235	45	25	67	102	713	1094	994	614	402	84	106
9	1000	194	6	6	22	19	247	927	598	1068	296	81	59
10	446	0	0	1	8	7	40	246	616	354	501	41	35
11	279	0	0	1	1	2	22	65	162	592	239	159	16
12	89	0	0	0	1	1	7	15	31	219	269	116	33
13	48	0	0	0	0	0	6	2	18	20	61	159	13
14	28	0	0	0	0	0	0	1	5	5	11	40	13
15	0	0	0	0	0	0	0	0	1	1	3	16	2
16	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	1	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	1	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	41200	12290	1301	411	1861	857	4338	8269	5335	6864	4117	957	618

Table 11. Estimates of cod abundance (thousands) from surveys in Division 2J in 1983-1992, in Campelen equivalent units.

Stratum depth (meters)	Stratum number	Area sq. nautical miles	Gadus 86-88 1983	Gadus 101-102 1984	Gadus 116-118 1985	Gadus 131-132 1986	Gadus 145-146 1987	Gadus 159-160 1988	Gadus 174-176 1989	Gadus 190-191 1990	Gadus 208-209 1991	Gadus 224-226 1992
	Mean survey date		05-Nov-83	05-Nov-84	30-Oct-85	11-Nov-86	06-Nov-87	14-Nov-88	10-Nov-89	12-Nov-90	14-Nov-91	05-Nov-92
101-200	201	1427	87811	52543	82806	99720	25126	319	0	0	0	0
	205	1823	122517	182501	48964	44029	34532	38745	502	1223	0	0
	206	2582	55637	142654	68017	134937	17607	83620	48332	2874	3197	3339
	207	2246	145830	101693	171902	37826	38648	45550	9825	15492	0	1545
201-300	202	440	5387	8111	4086	31746	7838	1025	0	0	0	0
	209	1608	108766	14599	39668	142610	48249	47602	140710	8590	9006	2522
	210	774	389901	16929	772	97706	479	10221	43414	34603	24230	2783
	213	1725	62645	33648	67470	102247	36569	43632	183006	89430	25390	1948
	214	1171	18102	112678	78314	157299	128223	115524	70582	18267	2942	897
	215	1270	25616	42569	26380	293011	27603	90521	1689	9434	2271	2114
	228	1428	22525	8643	2582	61157	4153	6679	14364	15813	154727	1964
	234	508	50198	16841	11926	22187	6825	2690	0	0	0	256
301-400	203	480	990	1552	638	5745	3962	5910	0	0	66	110
	208	448	5947	760	4622	9768	12572	1849	53462	8012	986	2465
	211	330	4698	908	2361	4880	4835	6945	35386	23197	67475	8058
	216	384	18	740	396	317	9720	1347	2562	872	687	106
	222	441	0	20	698	61	849	182	33214	4853	1597	364
	229	567	6357	208	3536	1872	338	1222	6214	5577	11518	1508
401-500	204	354	1704	5235	0	1802	1242	5405	268	146	0	162
	217	268	0	38	0	0	184	0	0	0	74	0
	227	686	47	0	0	157	236	252	3350	18150	6810	582
	235	420	9620	404	144	0	780	462	664	3178	12537	212
total strata fished <= 500 meters			1124316	743236	615282	1249077	410570	508714	647594	260268	323637	30960
1 STD strata fished <= 500 meters			320612	112688	88262	261581	66519	74633	112157	45978	165231	5287
501-750	212	664	0	91	23	761	365	548	206	3562	41423	274
	218	420	0	**nf**	0	0	0	0	0	0	0	0
	224	270	0	0	0	0	0	0	0	0	130	0
	230	237	0	0	0	0	0	98	0	978	0	0
501-750		1591	0	91 [1]	23	761	365	646	206	4540	41553	274
751-1000	219	213	0	**nf**	0	0	0	0	0	0	0	0
	231	182	0	0	0	0	0	0	**nf**[1]	0	0	325
	236	122	0	0	0	34	0	0	**nf**[1]	0	0	0
751-1000		517	0	0	0	34	0	0	0[1]	0	0	325
total strata fished > 500 meters			0	91	23	795	365	646	206	4540	41553	599
total all strata fished			1,124,317	743,328	615,304	1,249,871	410,936	509,360	647,797	264,807	365,191	31,560
1 STD all strata fished			320612	112687	88263	261582	66519	74635	112159	46014	170124	5304
mean number per tow			345.328	237.344	188.987	383.891	126.217	159.411	201.556	81.334	112.166	9.693

[1] Not all strata in the depth range have been fished. Strata not fished in the <= 500 meter depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.

Table 12. Estimates of cod biomass (t) from surveys in Division 2J in 1983-1992, in Campelen equivalent units.

Stratum depth (meters)	Stratum number	Area sq. nautical miles	Gadus 86-88 1983	Gadus 101-102 1984	Gadus 116-118 1985	Gadus 131-132 1986	Gadus 145-146 1987	Gadus 159-160 1988	Gadus 174-176 1989	Gadus 190-191 1990	Gadus 208-209 1991	Gadus 224-226 1992
Mean survey date			05-Nov-83	05-Nov-84	30-Oct-85	11-Nov-86	06-Nov-87	14-Nov-88	10-Nov-89	12-Nov-90	14-Nov-91	05-Nov-92
101-200	201	1427	61842	41743	58556	88676	27395	208	0	0	0	0
	205	1823	53701	95026	30679	38754	31421	61555	691	182	0	0
	206	2582	33286	121643	49111	123683	16999	92563	38555	661	1333	1489
	207	2246	46134	55054	107180	25989	36773	18803	2352	6370	0	649
201-300	202	440	8365	7647	3064	32711	11398	1874	0	0	0	0
	209	1608	127333	17017	35398	119210	56901	28242	52339	1670	3966	990
	210	774	241006	21752	1521	87332	737	10667	36642	12536	13406	1116
	213	1725	50086	27703	55229	98497	41997	53146	120476	34360	11859	587
	214	1171	19316	104048	77051	189715	170212	137161	56924	13766	1018	399
	215	1270	30986	31690	30602	379256	36553	146322	315	8508	1073	760
	228	1428	8049	7695	1244	52833	4800	10296	12552	8973	65772	672
	234	508	16910	11930	9173	22705	7342	5157	0	0	0	68
301-400	203	480	2250	3445	582	7875	6300	9640	0	0	45	77
	208	448	7465	1115	4301	8575	16641	3653	22845	3699	455	1091
	211	330	6334	1570	3287	4661	7667	7283	56896	10465	35048	3629
	216	384	52	1592	429	435	13557	2201	3178	255	287	25
	222	441	0	32	784	59	1192	247	9028	2559	579	175
	229	567	2354	263	3823	2399	340	1889	6166	4265	4906	595
401-500	204	354	2458	5863	0	2174	1732	8318	36	37	0	48
	217	268	0	60		0	211	0	0	0	45	0
	223	180	0	0	0	0	0	57	23	212	107	13
	227	686	217	0	0	224	341	353	5407	17904	4643	311
	235	420	4348	332	133	0	1090	717	962	1930	5594	101
total strata fished <= 500 meters			722492	557160	472147	1285763	491599	598478	425387	128352	150136	12795
1 STD strata fished <= 500 meters			177183	83218	65293	325107	31381	97959	218324	25701	72612	2315
501-750	212	664	0	nf	0	0	0	0	0	2196	20693	159
	218	420	0	0	0	0	0	0	0	0	62	0
	224	270	0	0	0	0	0	193	0	0	0	0
	230	237	0	0	0	0	0	0	0	1395	0	0
501-750		1591	0	0[1]	0	0	0	193	0	3591	20755	159
751-1000	219	213	0	nf	0	0	0	0	0	0	0	0
	231	182	0	0	0	0	0	0	nf	0	0	144
	236	122	0	0	0	62	0	0	nf	0	0	0
751-1000		517	0	0	0	62	0	0	0[1]	0	0	144
total strata fished > 500 meters			0	0	0	62	0	193	0	3591	20755	303
total all strata fished			722491	557302	472214	1287042	492144	599436	425874	131943	170892	13096
1 STD all strata fished			177183	83218	65293	325108	84935	97963	85921	25746	74135	2326

[1] **Not all strata in the depth range have been fished. Strata not fished in the <= 500 meter depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.**

Table 13. Estimates of cod abundance (thousands) from surveys in Division 2J in 1993-2004, in Campelen equivalent units for 1993 and 1994 and actual Campelen units for 1995-2004.

Stratum depth (meters)	Stratum number	Area sq. nautical miles	GADUS	GADUS	TELEOST	TELEOST	TELEOST	TELEOST	TELEOST	TELEOST	TEL 361	TEL 415,454,	Teleost	Teleost
			236-238	250-252	20-23	39	54-54	72-73	86-88	340-343	AN 399-400	TEL457	509-510	537-539
			1993	1994	1995-6	1996	1997	1998	1999	2000	2001	2002	2003	2004
Mean survey date			7-Nov-93	17-Nov-94	28-Dec-95	30-Oct-96	27-Oct-97	27-Oct-98	13-Nov-99	7-Nov-00	28-Nov-01	24-Dec-02	8-Dec-03	10-Nov-04
101-200	201	633	0	0	nf	0	0	44	44	0	0	0	44	44
	205	1594	63	219	nf	110	110	32	37	37	37	0	0	37
	206	1870	547	0	0	184	257	294	110	115	171	37	110	220
	207	2246	2128	2699	350	588	138	751	666	1280	447	1032	1122	623
	237	733	151	0	273	134	0	34	0	101	25	307	2041	178
	238	778	nf	0	nf	107	36	0	0	0	36	0	306	41
201-300	202	621	0	0	49	0	0	0	0	0	0	0	0	0
	209	680	374	514	327	249	62	243	374	187	28	218	258	234
	210	1035	5731	854	1424	320	214	178	854	676	261	269	473	570
	213	1583	871	0	2504	835	1085	871	290	1161	416	954	1327	617
	214	1341	1771	338	323	959	406	451	221	517	823	833	148	1402
	215	1302	1719	358	90	2917	1381	498	788	609	191	466	1197	2006
	228	2196	436	0	949	2068	1347	2001	868	944	1847	1729	874	1284
	234	530	0	0	nf	73	142	36	32	36	36	146	0	146
301-400	203	487	0	301	0	335	234	67	100	0	0	33	0	67
	208	588	0	162	809	566	0	40	40	335	144	0	352	243
	211	251	414	322	708	483	0	192	383	533	78	72	104	138
	216	360	0	173	927	715	99	74	275	198	303	297	57	371
	222	450	279	846	495	543	1021	272	371	495	954	836	340	464
	229	536	590	295	627	946	205	74	442	184	1180	885	442	332
401-500	204	288	0	0	16	20	0	0	14	0	0	20	0	0
	217	241	66	55	561	63	0	166	33	33	15	715	38	83
	223	158	0	0	880	91	54	19	0	nf	0	73	54	54
	227	598	795	0	370	1207	41	247	0	55	0	329	0	247
	235	414	1044	1006	541	101	85	85	0	0	0	159	28	85
	240	133	9	0	123	9	18	0	128	18	42	125	0	18
total strata fished <= 500 meters			16989	8145	12346	13625	6936	6669	6074	7516	7033	9534	9315	9503
upper			28803	16368	16367	17716	9046	8575	8163	10007	9222	12588	13125	11582
t-value			2.571	3.182	2.228	2.179	2.11	2.07	2.18	2.2	2.14	2.09	2.365	2.05
1STD strata fished <= 500 meters			4595	2584	1805	1877	1000	921	958	1132	1023	1461	1611	1014
501-750	212	557	77	128	69	136	77	0	0	38	0	72	82	0
	218	362	0	50	1660	75	0	0	0	0	0	100	0	25
	224	228	0	0	596	0	0	0	42	0	0	233	47	0
	230	185	0	34	13	0	0	0	13	13	0	480	0	0
	239	120	17	17	0	8	7	0	0	0	7	8	0	8
751-1000	219	283	0	0	0	0	0	0	0	0	0	0	0	0
	231	186	0	0	0	0	0	0	0	0	0	0	0	0
	236	193	0	0	12	0	0	0	0	0	0	0	0	0
1001-1250	220	330	nf	nf	nf	0	0		nf		0	0	0	0
	225	195	nf	nf	nf	0	0		0		0	0	0	0
	232	228	nf	nf	nf	0	0		0		0	0	0	0
1001-1250[1]		753	nf	nf	nf	0	0	0	0	0	0	0	0	
1251-1500	221	330	nf	nf	nf	0	0		0	0	0	0	0	0
	226	201	nf	nf	nf	0	0		0	0	0	0	0	0
	233	237	nf	nf	nf	0	0		0	0	0	0	0	0
1251-1500[1]		768	nf	nf	nf	0		0	0		0			
total strata fished > 500 meters			94	229	2350	219	84	0	55	51	7	893	129	33
total all strata fished			17082	8373	14654	13844	7020	6636	6129	7567	7040	10427	9445	9536
upper			28898	16608	19098	17946	9136	8538	8220	10060	9230	13495	13254	11615
t-value			2.571	3.182	2.16	2.179	2.11	2.07	2.18	2.2	2.14	2.09	2.365	2.05
1 STD all strata fished			4596	2588	2057	1883	1003	919	959	1133	1023	1468	1611	1014

[1] Not all strata in the depth range have been fished . Because of the short time series with the revised stratification scheme and a switch in 1995 to a different vessel and gear no attempt has been made to use a multiplicative model to fill strata which were not fished.

Table 14. Estimates of cod biomass (t) from surveys in Division 2J in 1993-2004, in Campelen equivalent units for 1993 and 1994 and actual Campelen units for 1995-2004.

Stratum depth (meters)	Stratum number	Area sq. nautical miles	GADUS 236-238 1993	GADUS 250-252 1994	TELEOST 20-23 1995-6	TELEOST 39 1996	TELOST 54-55 1997	TELOST 72-73 1998	TELOST 86-88 1999	TELEOST 340-343 2000	TEL 361 AN 399-400 2001	TEL 415,454, TEL457 2002	Teleost 509-510 2003	Teleost 537-539 2004
Mean survey date			7-Nov-93	17-Nov-94	28-Dec-95	30-Oct-96	27-Oct-97	27-Oct-98	13-Nov-99	7-Nov-00	28-Nov-01	24-Dec-02	8-Dec-03	10-Nov-04
101-200	201	633	0	0	nf	0	0	30	6	0	0	0	44	24
	205	1594	63	151	nf	16	42	5	4	42	41	0	0	5
	206	1870	155	0	0	62	125	186	24	47	90	20	7	76
	207	2246	452	507	44	57	110	406	156	220	107	26	204	114
	237	733	83	0	13	8	0	2	0	3	8	2	23	22
	238	778	nf	0	nf	21	27	0	0	0	11	0	2	59
201-300	202	621	0	0	9	0	0	0	0	0	0	0	0	0
	209	680	100	67	52	20	44	162	86	60	7	56	82	79
	210	1035	1158	139	108	26	112	98	168	271	77	72	121	254
	213	1583	346	0	336	214	586	639	180	398	208	389	715	410
	214	1341	700	174	39	273	186	289	127	303	355	460	122	878
	215	1302	443	210	21	959	586	404	625	436	88	371	646	1207
	228	2196	294	0	263	665	747	1258	280	433	514	613	329	572
	234	530	0	0	nf	22	83	3	1	3	17	31	0	54
301-400	203	487	0	220	0	136	157	67	107	0	0	23	0	26
	208	588	0	41	123	200	0	4	12	268	63	0	149	142
	211	251	241	110	141	81	0	130	71	208	36	17	27	43
	216	360	0	96	234	194	54	73	82	95	148	134	33	186
	222	450	146	276	124	290	495	194	200	193	363	374	257	297
	229	536	109	124	184	305	138	54	172	63	469	339	216	190
401-500	204	288	0	0	1	8	0	0	19	0	0	25	0	0
	217	241	67	19	135	26	0	177	14	7	10	401	37	40
	223	158	0	0	135	32	35	25	0	nf	0	47	43	42
	227	598	441	0	109	748	33	197	0	23	0	146	0	115
	235	414	318	559	175	84	30	71	0	0	0	58	8	74
	240	133	13	0	68	2	19	0	192	10	32	77	0	13
total strata fished <= 500 meters			5129	2693	2312	4261	3609	4483	2527	3082	2646	3680	3065	4921
upper			7096	3824	2905	6472	4574	5924	4023	4171	3345	4790	4226	5996
t-value			2.228	2.201	2.179	2.776	2.086	2.08	2.45	2.23	2.09	2.13	2.262	2.07
1STD strata fished <= 500 meters			883	514	272	796	463	693	611	488	334	521	513	519
501-750	212	557	93	89	15	22	49	0	0	10	0	45	115	0
	218	362	0	51	519	12	0	0	0	0	0	77	0	31
	224	228	0	0	205	0	0	0	45	0	0	152	68	0
	230	185	0	32	14	0	0	0	18	6	0	307	0	0
	239	120	17	11	0	2	3	0	0	0	1	7	0	1
751-1000	219	283	0	0	0	0	0	0	0	0	0	0	0	0
	231	186	0	0	0	0	0	0	0	0	0	0	0	0
	236	193	0	0	2	0	0	0	0	0	0	0	0	0
1001-1250	220	330	nf	nf	nf	0	0	0	nf	0	0	0	0	0
	225	195	nf	nf	nf	0	0	0	0	0	0	0	0	0
	232	228	nf	nf	nf	0	0	0	0	0	0	0	0	0
1001-1250[1]		753	nf	nf	nf	0	0	0	0	0	0			
1251-1500	221	330	nf	nf	nf	0	0	0	0	0	0	0	0	0
	226	201	nf	nf	nf	0	0	0	0	0	0	0	0	0
	233	237	nf	nf	nf	0	0	0	0	0	0	0	0	0
1251-1500[1]		768	nf	nf	nf	0	0	0	0	0	0			
total strata fished > 500 meters			110	183	755	36	52	0	63	16	1	588	183	32
total all strata fished			5238	3448	3067	4484	3662	4483	2590	3098	2647	4270	3248	4953
upper			7217	4019	3927	6621	4629	5924	4091	4187	3346	5387	4411	6028
t-value			2.228	2.179	2.262	2.776	2.08	2.08	2.45	2.23	2.09	2.12	2.262	2.07
1 STD all strata fished			888	262	380	770	465	693	613	488	334	527	514	519

[1] Not all strata in the depth range have been fished . Because of the short time series with the revised stratification scheme and a switch in 1995 to a different vessel and gear no attempt has been made to use a multiplicative model to fill strata which were not fished.

Table 15. Estimates of cod abundance (thousands) from surveys in Division 3K in 1983-1992, in Campelen equivalent units.

Stratum depth (meters)	Stratum number	Area sq. nautical miles	GADUS 87-88 1983	GADUS 101-103 1984	GADUS 117-118 1985	GADUS 131-132 1986	GADUS 146-147 1987	GADUS 160-161 1988	GADUS 175-176 1989	GADUS 191-192 1990	GADUS 209-210 1991	GADUS 224-226 1992
Mean survey date			26-Nov-83	23-Nov-84	18-Nov-85	01-Dec-86	27-Nov-87	05-Dec-88	05-Dec-89	04-Dec-90	04-Dec-91	26-Nov-92
101-200	618	1455	**17028**	24569	26453	64689	14954	57577	14811	13210	721	1268
	619	1588	**3835**	9955	1155	17476	6826	19598	63705	2578	0	218
201-300	620	2709	126888	110535	4685	135397	32793	100337	253826	11304	3780	2236
	621	2859	33593	32109	8338	27811	16059	32525	44025	14230	2517	131
	624	668	10016	9786	2550	2573	1746	3982	4901	24948	7076	735
	632	447	30765	**9851**	4591	4735	7410	51959	4888	22044	10336	1438
	634	1618	61564	31160	29182	323578	60702	21441	269092	4610	99321	694
	635	1274	7711	29442	4682	14225	3593	9534	5934	3505	1490	701
	636	1455	8807	17788	3828	21566	6777	12743	13850	715	1134	133
	637	1132	31704	73889	15928	46132	15805	24915	13766	6634	5320	156
301-400	623	1027	29291	51057	3697	4026	11782	23649	102872	50690	3155	5557
	625	850	4677	1988	7156	3196	11400	5554	21251	11693	1676	546
	626	919	6953	3266	2705	62324	5815	5006	12566	9260	1264	632
	628	1085	7935	4670	6617	2687	1582	18448	12575	5522	9303	4179
	629	495	2357	2557	1647	5720	938	7276	3135	6521	978	1853
	630	544	1497	2170	262	262	524	524	7009	1085	499	150
	633	2179	15312	21312	38293	96780	49404	15737	220703	243039	185926	7410
	638	2059	53867	17476	37259	36467	24472	23650	137139	360185	200000	7511
	639	1463	12449	5283	8780	15127	5980	12176	19270	52757	91771	2262
401-500	622	632	304	1434	283	1652	174	3188	21561	12476	1449	1594
	627	1194	1032	1038	372	4658	2633	1173	10505	85313	4506	3692
	631	1202	**1025**	33	472	207	3059	6063	42471	28964	15157	992
	640	198	**194**	0	9	14	0	109	2982	150	1970	17459
	645	204	0	0	9	**90**	112	28	4686	379	0	75
total strata fished <=500 meters			447748	451517	208952	891302	284541	457191	1307523	971810	649350	61622
1 STD strata fished <=500 meters			61132	68574	27228	321032	44267	73335	270219	184614	159892	17726
501-750[1]		917	0	0	0	**nf**	107	**nf**	**nf**	92	122	263
751-1000[1]		1340	**nf**	**nf**	0	**nf**	**nf**	**nf**	**nf**	128	56	0
total strata fished > 500 meters			0	0	0	0	107	0	0	220	178	263
total all strata fished			447748	451517	208952	891302	284648	457191	1307523	972029	649529	61886
1 STD all strata fished			61132	68574	27228	321032	44267	73335	270219	184614	159892	17726

[1] **Not all strata in the depth range have been fished. Strata not fished in the <= 500 meter depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.**

Table 16. Estimates of cod biomass (t) from surveys in Division 3K in 1983-1992, in Campelen equivalent units.

Stratum depth (meters)	Stratum number	Area sq. nautical miles	GADUS 87-88 1983	GADUS 101-103 1984	GADUS 117-118 1985	GADUS 131-132 1986	GADUS 146-147 1987	GADUS 160-161 1988	GADUS 175-176 1989	GADUS 191-192 1990	GADUS 209-210 1991	GADUS 224-226 1992
Mean survey date			26-Nov-83	23-Nov-84	18-Nov-85	01-Dec-86	27-Nov-87	05-Dec-88	05-Dec-89	04-Dec-90	04-Dec-91	26-Nov-92
101-200	618	1455	**7987**	18702	24894	53641	10200	2443	1575	1514	261	450
	619	1588	**1491**	4801	1113	3157	2538	1212	3363	154	0	119
201-300	620	2709	67557	87523	8223	131461	27088	13232	24447	1636	1158	847
	621	2859	18041	25813	6216	19356	3294	11590	7313	1021	359	194
	624	668	3920	3082	2340	2798	802	3087	1660	8649	3809	331
	632	447	33968	**10779**	4106	4540	7824	51549	2030	8677	5581	663
	634	1618	56301	24843	28663	436500	80357	19008	322401	1976	77639	450
	635	1274	4940	11970	3551	16754	3329	3843	2609	998	617	319
	636	1455	11657	13899	3977	13264	5871	9229	3577	431	334	138
	637	1132	36769	75369	15341	50718	15913	29982	13010	2665	2332	85
301-400	623	1027	23690	46679	5155	4602	17254	3662	22849	12857	1130	1960
	625	850	5410	2474	7062	3405	11136	5766	12105	4049	861	291
	626	919	5565	3377	4274	41267	4852	1188	5858	718	345	218
	628	1085	8807	4909	7807	2564	1484	7998	7102	2184	4028	1345
	629	495	2506	1739	955	5557	907	1391	1550	2003	95	535
	630	544	1452	1564	435	292	743	863	9065	644	267	85
	633	2179	15440	23201	39817	115810	66782	15297	148660	169097	132091	4366
	638	2059	56662	12773	35965	37822	31829	18946	184194	353107	150413	3564
	639	1463	17739	5242	8657	14185	6332	7526	7803	24244	74514	941
401-500	622	632	541	1487	215	1307	163	847	8794	2974	498	564
	627	1194	970	772	360	5307	1150	1208	4805	13523	1248	765
	631	1202	2700	138	493	273	3049	6448	31211	11300	8691	732
	640	198	**385**	0	16	22	0	299	2436	204	1231	16334
	645	204	0	0	50	**255**	139	122	1628	368	0	48
total strata fished <=500 meters			374634	370356	209686	964600	303038	216734	830045	624993	467505	35346
1 STD strata fished <=500 meters			51399	58138	26560	428297	61366	50225	289567	207590	128742	16146
501-750[1]		917	0	0	0	**nf**	174	**nf**	**nf**	72	133	258
751-1000[1]		1340	**nf**	**nf**	0	**nf**	**nf**	**nf**	**nf**	70	39	0
total strata fished > 500 meters			0	0	0	0	174	0	0	142	172	258
total all strata fished			374634	370356	209686	964600	303212	216734	830045	645136	649529	35604
1 STD all strata fished			51399	58138	26560	428297	61366	50225	289567	198748	159892	16146

[1] **Not all strata in the depth range have been fished. Strata not fished in the <= 500 meter depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.**

Table 17. Estimates of cod abundance (thousands) from surveys in Division 3K in 1993-2004, in Campelen equivalent units for 1993 and 1994 and actual Campelen units for 1995-2004.

					WT 176-81	WT 196-199	WT 217				WT 376, 398	TEL 415,457	TEL 509,510	
Depth		Stratum	GADUS	GADUS	TELEOST	TELEOST	TELOEST	TELEOST	TELEOST	TELEOST	TEL 362 397	WT431,455	513,514	Tel 539-542
range	Stratum	area	236-238	250-252	20-23	40-42	55-57	73-75	86-88	340-343	AN 399	WT 456	WT 511, 515	WT 588
meters	number	sq. mi.	1993	1994	1995-6	1996	1997	1998	1999	2000	2001	2002-3	2003-4	2004-5
	Mean survey date		23-Nov-93	7-Dec-94	26-Dec-95	14-Nov-96	18-Nov-97	14-Nov-98	30-Nov-99	23-Nov-00	8-Dec-01	20-Dec-02	15-Jan-04	14-Dec-04
101-200	618	1347	2409	159	1170	1887	1174	1065	865	2038	812	388	1346	1544
	619	1753	965	0	655	218	448	2411	281	2097	1021	512	1131	693
201-300	620	2545	3268	350	1465	915	764	1814	2514	3383	3172	1246	3214	2976
	621	2736	0	251	2580	303	444	494	1301	1700	1196	988	979	3403
	624	1105	391	152	813	2432	395	973	472	456	1277	924	213	730
	634	1555	468	642	214	1246	31	672	397	616	1497	937	299	1176
	635	1274	467	0	88	386	243	491	245	361	70	257	70	0
	636	1455	734	200	286	133	267	367	300	291	392	371	272	534
	637	1132	4983	389	242	810	125	529	1093	nf	352	775	436	799
301-400	617	593	1876	184	693	109	1006	160	547	1332	2882	236	109	1224
	623	494	1138	0	578	510	136	217	34	136	1446	755	442	1665
	625	888	285	0	342	131	305	329	1160	275	912	1000	92	1530
	626	1113	714	204	2709	1415	31	1868	4651	1217	3253	2927	1654	7196
	628	1085	1443	299	1556	826	358	1151	2507	2478	1791	2047	1944	2158
	629	495	908	375	545	68	69	102	272	393	230	847	306	180
	630	332	0	0	41	0	69	23	69	95	15	0	0	23
	633	2067	1153	2218	851	1381	885	695	1788	853	876	2428	903	2514
	638	2059	8780	1187	1252	2155	472	661	5413	7308	5119	13407	3191	3682
	639	1463	1489	1711	712	1025	537	503	1540	786	690	7864	973	738
401-500	622	691	1141	57	542	230	63	507	405	665	602	383	289	475
	627	1255	2992	604	4924	1918	514	414	2463	9091	699	1746	886	863
	631	1321	0	182	501	273	84	0	784	54	99	199	346	91
	640	69	228	16	218	25	43	47	66	47	19	71	100	20
	645	216	79	119	134	30	15	43	59	104	66	45	178	193
	650	134	995	65	276	92	350	74	78	nf	46	1501	535	65
total strata fished <= 500 meters			36906	9364	23387	18518	8828	15610	29304	35776	28534	41854	19908	34468
upper			49711	14727	27099	22878	10868	19783	35059	59488	35927	64414	23813	41996
t-value			2.201	2.228	2.086	2.06	2.16	2.12	2.04	2.78	2.13	2.2	2.017	2.12
1 STD strata fished <= 500 meters			5818	2407	1779	2117	944	1968	2821	8529	3471	10255	1936	3551
501-750	641	230	11	21	63	47	0	16	0	nf	16	662	158	16
	646	325	75	0	0	0	22	0	89	0	0	45	224	1565
	651	359	16	123	691	25	0	198	0	nf	28	85	1580	0
751-1000	642	418	115	0	0	0	0	0	0	0	0	0	0	0
	647	360	0	0	0	0	0	0	0	0	0	0	0	0
	652	516	142	106	0	0	0	71	35	0	0	0	0	0
1001-1250	643	733	nf	nf	0	0		0	0		0	0	0	0
	648								0		16	0	0	0
	653	531	0	nf	0	0		0	0		0	0	0	0
1001-1250[3]		1264	nf	nf	0	0	0	0	0	0	16	0	0	
1251-1500	644	474	nf	nf	0	0		0	0	0	0	0	0	0
	649	212						0	0	0	0	0	0	0
	654	479	nf	nf	0	0		0	0	0	0	0	0	0
1251-1500[3]		1165	nf	nf	0	0	0	0	0	0	0	0	0	0
total strata fished > 500 meters			359	250	754	72	22	285	124	0	60	792	1962	1581
total all strata fished			37265	9612	24142	18590	8850	15896	29433	39110	28595	42644	21868	36049
upper			50073	14985	27956	22950	10891	20071	35187	61174	35987	65206	25860	44372
t-value			2.201	2.228	2.08	2.06	2.16	2.12	2.04	2.57	2.13	2.2	2.014	2.14
1 STD all strata fished			5819	2412	1834	2117	945	1969	2821	8585	3470	10255	1982	3889

[1] Not all strata in the depth range have been fished. Because of the short time series with the revised stratification scheme and a switch in 1995 to a different vessel and gear no attempt has been made to use a multiplicative model to fill strata which were not fished.

Table 18. Estimates of cod biomass (t) from surveys in Division 3K in 1993-2004, in Campelen equivalent units for 1993 and 1994 and actual Campelen units for 1995-2004.

Depth range meters	Stratum number	Stratum area sq. mi.	GADUS 236-238 1993	GADUS 250-252 1994	WT 176-181 TELEOST 20-23 1995-6	WT 196-199 TELEOST 40-42 1996	WT 217 TELOEST 55-57 1997	TELEOST 73-75 1998	TELEOST 86-88 1999	TELEOST 340-343 2000	WT 376/ 398 TEL 362 397 AN 399 2001	TEL 415,457 WT431,455 WT 456 2002-3	TEL 509,510 513,514 WT 511, 515 2003-4	el 539-542 WT 588 2004-5
Mean survey date			23-Nov-93	7-Dec-94	26-Dec-95	14-Nov-96	18-Nov-97	14-Nov-98	30-Nov-99	23-Nov-00	8-Dec-01	20-Dec-02	15-Jan-04	14-Dec-04
101-200	618	1347	721	40	87	221	291	170	56	252	99	72	85	170
	619	1753	708	0	32	42	36	158	20	154	97	101	38	80
201-300	620	2545	614	118	238	230	203	471	245	415	649	164	595	671
	621	2736	0	267	302	77	202	207	296	397	169	186	44	567
	624	1105	177	85	251	714	207	752	263	225	492	364	64	342
	634	1555	189	417	97	391	7	300	178	152	637	424	219	481
	635	1274	189	0	10	94	208	322	76	104	17	82	6	0
	636	1455	334	141	92	39	234	303	171	260	96	93	49	131
	637	1132	2039	74	74	358	38	321	575	nf	168	235	109	253
301-400	617	593	383	74	97	14	359	95	212	237	748	97	53	306
	623	494	213	0	32	144	37	70	10	41	309	153	107	272
	625	888	229	0	99	66	139	166	573	173	296	342	75	658
	626	1113	468	89	289	340	6	1034	1217	259	716	543	156	1366
	628	1085	736	80	353	409	274	647	837	524	953	588	171	554
	629	495	343	20	70	12	45	54	116	192	97	176	69	21
	630	332	0	0	11	0	53	14	30	38	8	0	0	3
	633	2067	502	1067	420	535	516	624	1138	615	543	1105	534	1114
	638	2059	3913	401	635	720	232	593	3372	3974	2863	3385	1080	1691
	639	1463	622	761	290	415	260	494	1124	780	418	2542	422	265
401-500	622	691	299	32	68	55	19	143	178	138	214	70	218	106
	627	1255	891	226	702	466	211	150	825	2917	135	438	194	166
	631	1321	0	208	99	45	90	0	481	27	59	36	216	36
	640	69	131	11	90	13	30	71	96	37	13	35	58	29
	645	216	84	87	48	14	11	44	62	84	63	48	111	254
	650	134	441	43	112	40	292	76	78	nf	30	613	236	72
total strata fished <= 500 meters			14227	4241	4600	5455	3998	7280	12230	11994	9890	11889	4912	9609
upper			18515	6644	5485	6692	5034	9559	14902	19284	12834	18138	6118	11713
t-value			2.228	2.262	2.056	2.037	2.145	2.23	2.07	2.45	2.14	2.18	2.023	2.05
1 STD strata fished <= 500 meters			1925	1062	430	607	483	1022	1291	2976	1376	2867	596	1026
501-750	641	230	16	18	83	101	0	13	0	nf	14	438	175	17
	646	325	51	0	0	0	42	0	200	0	0	41	208	749
	651	359	25	116	317	30	0	133	0	nf	35	78	1274	0
751-1000	642	418	72	0	0	0	0	0	0	0	0	0	0	0
	647	360	0	0	0	0	0	0	0	0	0	0	0	0
	652	516	208	62	0	0	0	96	89	0	0	0	0	0
1001-1250	643	733	nf	nf	0	0	0	0	0	0	0	0	0	0
	648							0	0	0	7	0	0	0
	653	531	0	nf	0	0	0	0	0	0	0	0	0	0
1001-1250[3]		1264	nf	nf	0	0	0	0	0	0	7	0	0	
1251-1500	644	474	nf	nf	0	0	0	0	0	0	0	0	0	0
	649	212						0	0	0	0	0	0	0
	654	479	nf	nf	0	0	0	0	0	0	0	0	0	0
1251-1500[3]		1165	nf	nf	0	0	0	0	0	0	0	0	0	0
total strata fished > 500 meters			372	196	400	131	42	242	289	0	56	557	1657	766
total all strata fished			14598	4437	5000	5586	4040	7522	12519	12585	9946	12446	6569	10375
upper			18892	6848	6010	6825	5081	9812	15222	19889	12892	18696	8435	13381
t-value			2.228	2.262	2.11	2.037	2.145	2.23	2.06	2.45	2.14	2.18	2.365	2.36
1 STD all strata fished			1927	1066	479	608	485	1027	1312	2981	1377	2867	789	1274

[1] Not all strata in the depth range have been fished. Because of the short time series with the revised stratification scheme and a switch in 1995 to a different vessel and gear no attempt has been made to use a multiplicative model to fill strata which were not fished.

Table 19. Estimates of cod abundance (thousands) from surveys in Division 3L in 1992-2004 in depths <= 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fath)	Stratum number	Area sq. nautical miles	WT	WT	WT	AN	WT	WT	WT	WT	WT	WT	WT	WT
			7-9	16-18	37-39	72	65	78	87	101	114-115	129-130	145-146	160-162
			1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Mean survey date			27-Oct-83	15-Aug-84	27-Oct-85	21-Nov-86	24-Oct-87	3-Nov-88	20-Oct-89	5-Nov-90	21-Nov-91	16-Nov-92	23-Nov-93	22-Nov-94
31-50	350	2071	26886	62391	66442	43614	15131	13276	10854	5911	5359	1140	1804	122
	363	1780	38933	73152	143316	6156	21384	23286	43993	52247	3702	13036	408	367
	371	1121	20972	36304	5199	565	3547	4472	193	7556	411	1079	103	0
	372	2460	157018	160636	65709	16318	57710	16269	32627	141824	3774	2919	299	0
	384	1120	29119	73645	1560	801	34383	1489	986	41791	1061	146	154	0
51-100	328	1519	**6868**	1985	1802	37264	2507	8806	1224	2090	279	1114	488	139
	341	1574	14723	8401	4949	6124	337	1245	298	1985	505	217	1516	0
	342	585	2837	4466	912	885	1073	429	80	2052	161	54	0	80
	343	525	915	14408	1517	1974	337	650	24	1372	481	722	72	96
	348	2120	8934	34810	6978	6008	3143	3995	6189	6389	1896	3208	**nf**	219
	349	2114	9306	62170	15645	8724	2472	7302	1745	4736	3722	58	1939	208
	364	2817	25576	97381	20064	3720	4789	10048	1656	13595	291	388	1421	323
	365	1041	7074	102281	4242	8821	1456	1690	573	895	1575	286	95	95
	370	1320	5811	52295	2865	2905	1059	623	121	1888	121	484	666	0
	385	2356	5445	20391	756	4497	972	25	29	1713	389	648	0	0
	390	1481	815	33751	553	5229	23276	3107	2183	1290	0	136	0	0
101-150	344	1494	5823	15722	10733	8250	5600	4874	4580	9454	3186	5446	2363	771
	347	983	5995	11719	3056	3651	2502	10628	4571	30560	609	676	439	34
	366	1394	11314	56011	**51115**	59062	25367	66130	17888	9812	19359	44544	2972	115
	369	961	9628	14919	5222	53011	11336	12241	1005	2809	12559	1884	227	0
	386	983	**10318**	8587	4327	14705	7167	4895	6464	7099	135	766	135	0
	389	821	**10850**	3614	4518	4179	49636	13270	10023	2936	10842	0	0	0
	391	282	16778	291	6440	485	2289	427	1028	1629	233	129	116	0
151-200	345	1432	6821	7936	14730	12410	8963	11285	5881	11977	4432	985	1510	542
	346	865	17634	9023	9567	14120	30253	27058	9073	14517	37387	33292	1417	136
	368	334	**21257**	2688	6524	12497	3101	5008	1861	11555	27437	30338	15627	88
	387	718	**12466**	19062	3704	22519	4708	1753	1350	3325	2963	2864	2601	779
	388	361	**5572**	4817	1341	**3629**	844	1813	5761	1962	1556	579	414	177
	392	145	150	1107	339	110	10	289	40	598	259	20	27	0
total strata fished <= 200 fathoms			428505	993964	464125	358606	325352	256383	172299	395569	144684	147159	36813	4292
ADJUSTED			495838	993963	464125	362233	325352	256383	172300	395567	144684	147158	36813	4291
upper			531562	1232300	652696	472366	434746	312134	235628	525307	181155	215462	65605	6233
t-value			2.16	2.228	2.131	2.262	2.16	2.069	2.06	2.201	2.08	2.012	2.306	2.042
1 STD strata fished <= 200 fathor			47712	106973	88489	50292	50645	26946	30742	58945	17534	33948	12486	951

[1] Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.

cont'd

Table 19 (cont'd). Estimates of cod abundance (thousands) from surveys in Division 3L in 1992-2004 in depths <= 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fath)	Stratum number	Area sq. nautical miles	WT 176-181 1995	Tel 41 WT 196-198 1996	Tel 55-57 WT 213-217 1997	WT 230-233 1998	WT 245-247 1999	/VT 321-323 Tel 342-343 2000	AN 399 WT 373-376 TEL 357-358 361 2001	el 412 ,413 Tel 415 /T 428-431 2002-3	Tel 513 /T 487-489 WT 511 2003	/T 558-559 WT 587 Tel 540 2004
Mean survey date			27-Nov-95	2-Nov-96	27-Nov-97	15-Nov-98	29-Nov-99	28-Nov-00	15-Nov-01		5-Dec-03	5-Dec-04
31-50	350	2071	1045	285	570	773	1587	936	1420	512	692	1750
	363	1780	365	82	1306	481	367	184	245	408	245	542
	371	1121	31	0	0	0	39	0	0	77	77	77
	372	2460	353	414	42	1114	1269	1523	926	550	296	296
	384	1120	0	0	0	0	385	77	0	39	0	77
51-100	328	1519	0	334	376	334	1226	209	5391	775	3636	1319
	341	1574	36	289	54	223	1256	476	1261	558	693	1291
	342	585	40	121	40	80	724	201	188	40	201	483
	343	525	36	0	68	0	361	397	36	36	144	144
	348	2120	250	393	167	194	767	292	1333	287	329	1280
	349	2114	122	166	344	162	955	614	706	291	706	1015
	364	2817	43	116	525	0	775	1163	388	172	400	2177
	365	1041	215	207	191	0	0	**nf**	95	239	0	
	370	1320	73	0	91	0	0	257	45	40	52	
	385	2356	0	36	0	41	41	0	162	0	0	41
	390	1481	34	0	0	0	204	0	0	0	41	41
101-150	344	1494	530	2950	914	715	1548	2023	968	1219	2089	4091
	347	983	199	391	541	406	316	371	496	225	406	406
	366	1394	230	236	652	443	345	671	5420	3209	920	
	369	961	78	0	220	39	1332	0	176	44	176	
	386	983	0	45	0	0	45	0	45	45	0	
	389	821	38	0	38	0	151	113	38	0	0	225
	391	282	0	0	19	0	97	19	0	17	19	39
151-200	345	1432	2780	433	302	653	2863	4436	3467	1055	1435	2272
	346	865	754	379	1269	297	881	4557	3570	806	535	801
	368	334	299	128	459	368	980	9396	694	184	436	
	387	718	66	44	1514	132	527	494	329	88	99	
	388	361	99	0	135	0	5313	472	221	50	0	199
	392	145	19	18	20	0	928	130	104	18	9	38
total strata fished <= 200 fathoms			7732	7066	9859	6454	25281	29010	27724	10984	13638	18605
ADJUSTED			7735	7067	9859	6454	25281	29010	27724	10984	13638	
upper			12328	12052	15027	8524	95232	52913	42861	15550	18275	22936
t-value			2.306	2.571	2.776	2.05	12.71	4.3	2.23	2.36	2.365	2.06
1 STD strata fished <= 200 fathor			1993	1939	1862	1010	5504	5559	6788	1935	1961	2102

[1] Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.

Table 20. Estimates of cod biomass (t) from surveys in Division 3L in 1992-2004 in depths <= 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fath)	Stratum number	Area sq. nautical miles	WT 7-9 1983	WT 16-18 1984	WT 37-39 1985	AN 72 1986	WT 65 1987	WT 78 1988	WT 87 1989	WT 101 1990	WT 114-115 1991	WT 129-130 1992	WT 145-146 1993	WT 160-162 1994
Mean survey date			27-Oct-83	15-Aug-84	27-Oct-85	21-Nov-86	24-Oct-87	3-Nov-88	20-Oct-89	5-Nov-90	21-Nov-91	16-Nov-92	23-Nov-93	22-Nov-94
31-50	350	2071	18204	42081	35227	46248	14242	16885	10769	6602	6434	1877	1522	179
	363	1780	36935	50726	103274	9116	22124	30177	33959	35121	4266	7504	344	211
	371	1121	13316	24055	3285	366	4935	7746	457	9110	481	893	91	0
	372	2460	100388	74560	62776	22328	68454	19194	29816	177108	3164	1896	287	0
	384	1120	15999	57404	1314	163	27226	1681	223	61815	674	127	67	0
51-100	328	1519	**2634**	832	1378	11971	603	3397	1101	415	185	1748	166	248
	341	1574	4517	5043	2694	4218	473	1273	198	1237	920	253	289	0
	342	585	752	1733	554	588	451	583	114	1029	383	123	0	36
	343	525	1341	6036	518	1930	404	661	90	653	132	459	79	34
	348	2120	6763	24084	4851	5686	3229	3906	4158	2995	1666	1504	**nf**	322
	349	2114	5245	23149	9512	7711	2203	8207	2690	3630	5454	66	1755	54
	364	2817	5306	21027	4966	2813	3463	7216	1681	6851	915	526	873	302
	365	1041	2101	20303	2383	4292	2116	1961	797	509	2814	347	54	114
	370	1320	2403	21444	1579	579	1605	1128	224	1159	189	673	171	0
	385	2356	1719	5657	316	2583	1624	303	110	1620	300	735	0	0
	390	1481	1366	6250	108	561	1850	516	294	283	0	81	0	0
101-150	344	1494	3698	12067	9056	7635	4726	2746	2435	5079	809	3003	988	382
	347	983	6183	10733	2265	3960	1906	9386	5239	18473	369	181	351	20
	366	1394	15941	18725	54100	70142	28721	76378	18189	8194	15225	40824	2426	116
	369	961	9321	8962	8086	65455	19792	12361	3266	3223	13072	937	180	0
	386	983	**8056**	5281	6595	23005	5487	6410	7472	10209	124	366	194	0
	389	821	**5277**	4726	5017	3420	9036	2951	5134	3838	3388	0	0	0
	391	282	1418	157	1522	711	400	76	158	577	74	18	53	0
151-200	345	1432	10540	7499	15729	16629	9962	14557	7883	7575	1775	736	957	245
	346	865	14781	6034	10546	15984	36414	33516	14619	13512	27945	29383	702	91
	368	334	**23841**	2557	10438	21732	7227	7539	4904	13883	26629	29646	10776	80
	387	718	**13000**	14254	7063	37565	5152	2623	1146	9129	3515	2018	1984	321
	388	361	**5572**	1730	3116	**3629**	389	1067	3506	1564	740	390	268	119
	392	145	172	245	251	43	15	110	55	276	117	9	19	0
total strata fished <= 200 fathoms			278412	477355	368514	387438	284230	274553	160688	405668	121761	126323	24594	2873
ADJUSTED			336789	477354	368519	391063	284229	274554	160687	405669	121759	126323	24596	2874
upper			361946	559984	491927	534112	349929	337286	205564	592708	154941	193308	44710	3895
t-value			2.365	2.04	2.12	2.365	2.056	2.086	2.069	2.306	2.131	2.014	2.306	2.035
1 STD strata fished <= 200 fathoms			35321	40504	58214	62019	31955	30073	21690	81110	15570	33260	8723	502

[1] Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.

cont'd

Table 20 (cont'd). Estimates of cod biomass (t) from surveys in Division 3L in 1992-2004 in depths <= 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fath)	Stratum number	Area sq. nautical miles		Teleost 41	Tel 55-57				AN 399	Tel 412 ,413	Tel 513 /	T 558-559
			WT	WT	WT	WT	WT	WT 321-323	WT 373-376	Tel 415	WT 487-489	WT 587
			176-181	196-199	213-217	230-233	246-248	Tel 342-343	TEL 357-358 361	WT 428-431	WT 511	Tel 540
			1995	1996	1997	1998	1999	2000	2001	2002-3	2003	2004
Mean survey date			27-Nov-95	2-Nov-96	27-Nov-97	15-Nov-98	29-Nov-99	28-Nov-00	15-Nov-01	12-Nov-02	5-Dec-03	5-Dec-04
31-50	350	2071	1276	362	1355	997	1342	842	2442	367	1181	179
	363	1780	506	224	2895	152	80	28	588	1230	232	42
	371	1121	10	0	0	0	26	0	0	73	51	11
	372	2460	54	557	29	431	608	66	1303	1074	49	127
	384	1120	0	0	0	0	212	4	0	0	0	33
51-100	328	1519	0	537	1014	144	195	41	3995	145	407	394
	341	1574	2	248	16	290	1043	120	475	272	304	181
	342	585	22	184	66	5	164	135	79	13	74	54
	343	525	18	0	45	0	69	130	5	6	44	31
	348	2120	181	326	144	191	144	55	583	174	122	300
	349	2114	88	117	327	357	531	228	658	114	88	313
	364	2817	1	95	353	0	331	403	59	82	97	712
	365	1041	129	147	72	0	0	**nf**	72	72	0	
	370	1320	72	0	41	0	0	107	17	22	2	
	385	2356	0	11	0	57	13	0	77	0	0	2
	390	1481	13	0	0	0	81	0	0	0	8	16
101-150	344	1494	233	2214	221	409	802	908	274	601	765	1343
	347	983	99	324	259	407	81	87	224	175	109	144
	366	1394	121	87	264	223	58	321	2527	1572	292	
	369	961	174	0	170	4	1048	0	64	15	71	
	386	983	0	20	0	0	26	0	18	10	0	
	389	821	12	0	35	0	58	54	9	0	0	102
	391	282	0	0	21	0	178	1	0	31	6	4
151-200	345	1432	1441	370	76	512	1301	1299	2178	709	658	627
	346	865	459	243	466	287	414	1359	2350	394	77	618
	368	334	129	48	181	240	954	8268	290	169	201	
	387	718	25	19	851	99	284	227	180	30	2	
	388	361	35	0	78	0	3080	335	140	97	0	23
	392	145	15	7	10	0	489	51	97	10	7	11
total strata fished <= 200 fathoms			5114	6140	8991	4804	13611	15070	18706	7460	4849	5266
ADJUSTED			5115	6140	8991	4804	13611	15070	18706	7460	4849	
upper			7661	9799	13920	6901	56006	83892	27204	10528	7539	6640
t-value			2.145	2.306	2.228	2.04	12.71	12.71	2.12	2.13	2.228	2.09
1 STD strata fished <= 200 fathoms			1187	1587	2212	1028	3336	5415	4008	1440	1207	657

[1] Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.

Table 21. Estimates of cod abundance (thousands) from surveys in Division 3L in 1992-2004 in depths > 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fathoms)	Stratum number	Area sq. nautical miles	WT	WT	WT	AN	WT	WT	WT	WT	WT	WT	WT	WT
			7-9	16-18	37-39	72	65	78	87	101	114-115	129-130	145-146	160-162
			1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Mean survey date			27-Oct-83	15-Aug-84	27-Oct-85	21-Nov-86	24-Oct-87	3-Nov-88	20-Oct-89	5-Nov-90	21-Nov-91	16-Nov-92	23-Nov-93	22-Nov-94
201-300	729	186	nf	320	0	0	nf	nf	nf	38	0	13	213	0
	731	216	nf	15	30	nf	nf	nf	nf	15	30	168	277	21
	733	468	nf	1481	43	nf	nf	nf	nf	386	21	494	1223	107
	735	272	nf	25	94	0	nf	nf	nf	nf	923	886	9155	180
301-400	730	170	nf	0	0	nf	nf	nf	nf	nf	0	0	0	8
	732	231	nf	0	0	nf	nf	nf	nf	0	0	0	0	0
	734	228	nf	0	0	nf	nf	nf	nf	0	0	0	31	42
	736	175	0	nf	0	0	nf	nf	nf	0	24	0	96	28
401-500	737	227	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	741	223	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	745	348	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	748	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
401-500		957	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
501-600	738	221	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	742	206	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	746	392	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	749	126	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
501-600		945	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	739	254	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	743	211	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	747	724	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	750	556	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700		1745	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	740	264	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	744	280	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	751	229	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800		773	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
total strata fished > 200 fathioms			0	1841	167	0	0	0	0	439	998	1561	10995	386
total all strata fished offshore			428505	995804	464291	358606	325352	256383	172299	396008	145682	148719	47809	4678
upper			531562	1234157	652863	472366	434746	312134	235628	525748	182099	217045	77554	6627
t-value			2.16	2.228	2.131	2.262	2.16	2.069	2.06	2.201	2.074	2.012	2.228	2.042
1 STD all strata fished offshore			47712	106981	88490	50292	50645	26946	30742	58946	17559	33959	13351	954

nf Not all strata in the depth range hav been fished. Strata not fished in the greater than 200 fathom depth range have not been filled using a multiplicative model.

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Table 21 (cont'd). Estimates of cod abundance (thousands) from surveys in Division 3L in 1992-2004 in depths > 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fathoms)	Stratum number	Area sq. nautical miles	WT 176-181 1995	Teleost 41 WT 196-198 1996	Tel 55-57 WT 213-217 1997	WT 230-233 1998	WT 246-249 1999	WT 321-323 Tel 342-343 2000	AN 399 WT 373-376 TEL 357-358 361 2001	Tel 412 ,41: Tel 415 VT 428-431 2002-3	Tel 513 WT 487-4ɛ WT 511 2003	/T 558-559 WT 587 Tel 540 2004
Mean survey date			27-Nov-95	2-Nov-96	27-Nov-97	18-Nov-98	29-Nov-99	28-Nov-00	15-Nov-01	12-Nov-02	5-Dec-03	5-Dec-04
201-300	729	186	0	0	13	0	38	0	38	0	13	36
	731	216	13	nf	178	0	40	208	106	0	0	17
	733	468	32	0	193	61	64	101	444	29	322	0
	735	272	187	0	449	112	67	3528	692	83	337	
301-400	730	170	0	0	0	0	0	0	0	0	0	0
	732	231	0	0	0	0	0	0	0	0	0	0
	734	228	0	0	167	0	0	0	0	0	0	
	736	175	32	0	144	0	24	0	12	0	139	
401-500	737	227	16	0	0	0	0	0	0	0	0	
	741	223	nf	0	0	0	0	0	0	0	0	
	745	348	nf	0	0	0	0	0	0	0	0	
	748	159	nf	0	0	0	0	0	0	0	0	
401-500		957	16	0	0	0	0	0	0	0	0	
501-600	738	221	0	0	0	0	0	0	0	0	0	
	742	206	nf	0	0	0	0	0	0	0	0	
	746	392	nf	0	0	0	0	0	0	0	0	
	749	126	nf	0	0	0	nf	0	0	0	0	
501-600		945	0	0	0	0	0	0	0	0	0	
601-700	739	254	nf	0	0	0	0	0	0	0	0	
	743	211	nf	0	0	0	0	0	0	0	0	
	747	724	nf	0	0	0	0	0	0	0	0	
	750	556	nf	0	0	0	0	0	0	0	0	
601-700		1745	nf	0	0	0	0	0	0			
701-800	740	264	nf	0	0	0	0	0	0	0	0	
	744	280	nf	0	0	0	nf	0	0	0	0	
	751	229	nf	0	0	0	nf	0	0	0	0	
701-800		773	nf	0	0	0	0	0	0	0	0	
total strata fished > 200 fathioms			280	0	1144	173	233	3837	1292	112	811	53
total all strata fished offshore			8013	7066	11003	6628	25514	32846	29017	11096	14448	18657
upper			12630	12052	19944	8699	95474	58560	44211	15667	19068	22989
t-value			2.306	2.571	2.447	2.05	12.71	4.3	2.23	2.36	2.306	2.06
1 STD all strata fished offshore			2002	1939	3654	1010	5504	5980	6813	1937	2003	2103

nf Not all strata in the depth range hav been fished. Strata not fished in the greater than 200 fathom depth range have not been filled using a multiplicative model.

Table 22. Estimates of cod biomass (t) from surveys in Division 3L in 1992-2004 in depths > 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fathoms)	Stratum number	Area sq. nautical miles	WT	WT	WT	AN	WT	WT	WT	WT	WT	WT	WT	WT
			7-9	16-18	37-39	72	65	78	87	101	114-115	129-130	145-146	160-162
			1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Mean survey date			27-Oct-83	15-Aug-84	27-Oct-85	21-Nov-86	24-Oct-87	3-Nov-88	20-Oct-89	5-Nov-90	21-Nov-91	16-Nov-92	23-Nov-93	22-Nov-94
201-300	729	186	nf	206	0	0	nf	nf	nf	107	0	45	208	0
	731	216	nf	92	248	nf	nf	nf	nf	19	49	131	177	23
	733	468	nf	1678	461	nf	nf	nf	nf	937	28	316	837	85
	735	272	nf	276	466	0	nf	nf	nf	nf	1214	1233	4809	91
301-400	730	170	nf	0	0	nf	nf	nf	nf	nf	0	0	0	8
	732	231	nf	0	0	nf	nf	nf	nf	0	0	0	0	0
	734	228	nf	0	0	nf	nf	nf	nf	0	0	0	18	42
	736	175	0	nf	0	0	nf	nf	nf	0	56	0	51	28
401-500	737	227	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	741	223	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	745	348	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	748	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
401-500		957	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
501-600	738	221	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	742	206	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	746	392	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	749	126	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
501-600		945	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700	739	254	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	743	211	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	747	724	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	750	556	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
601-700		1745	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800	740	264	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	744	280	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
	751	229	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
701-800		773	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf	nf
total strata fished > 200 fathoms			0	2252	1175	0	0	0	0	1063	1347	1725	6100	277
total all strata fished offshore			278412	479606	369689	387438	284230	274553	160688	406730	123108	128048	30694	3149
upper			361946	562277	493108	534112	349929	337286	205564	593770	156389	195072	51127	4178
t-value			2.365	2.04	2.12	2.365	2.056	2.086	2.069	2.306	2.131	2.014	2.262	2.032
1 STD all strata fished offshore			35321	40525	58217	62019	31955	30073	21690	81110	15618	33279	9033	506

nf Not all strata in the depth range hav been fished. Strata not fished in the greater than 200 fathom depth range have not been filled using a multiplicative model.

cont'd

Table 22 (cont'd). Estimates of cod biomass (t) from surveys in Division 3L in 1992-2004 in depths > 200 fathoms. The 1992-1994 data are in Campelen equivalent units and the 1995-2004 data are in actual Campelen units.

Stratum depth (fathoms)	Stratum number	Area sq. nautical miles		Teleost 41	Tel 55-57				AN 399	Tel 412 ,41:	Tel 513	'T 558-559
			WT	WT	WT	WT	WT	WT 321-323	WT 373-376	Tel 415	WT 487-4ε	WT 587
			176-181	196-198	213-217	230-233	246-249	Tel 342-343	TEL 357-358 361	VT 428-431	WT 511	Tel 540
			1995	1996	1997	1998	1999	2000	2001	2002-3	2003	2004
	Mean survey date		27-Nov-95	2-Nov-96	27-Nov-97	18-Nov-98	29-Nov-99	28-Nov-00	15-Nov-01	12-Nov-02	5-Dec-03	5-Dec-04
201-300	729	186	0	0	19	0	67	0	45	0	42	30
	731	216	5	nf	178	0	20	165	108	0	0	4
	733	468	14	0	161	68	66	110	261	36	156	0
	735	272	109	0	369	167	104	3973	697	155	226	
301-400	730	170	0	0	0	0	0	0	0	0	0	0
	732	231	0	0	0	0	0	0	0	0	0	0
	734	228	0	0	313	0	0	0	0	0	0	
	736	175	15	0	169	0	37	0	7	0	164	
									0			
401-500	737	227	17	0	0	0	0	0	0	0	0	
	741	223	nf	0	0	0	0	0	0	0	0	
	745	348	nf	0	0	0	0	0	0	0	0	
	748	159	nf	0	0	0	0	0	0	0	0	
401-500		957	17	0	0	0	0	0	0	0	0	
501-600	738	221	0	0	0	0	0		0	0	0	
	742	206	nf	0	0	0	0		0	0	0	
	746	392	nf	0	0	0	0		0	0	0	
	749	126	nf	0	0	0	nf		0	0	0	
501-600		945	0	0	0	0	0	0	0	0	0	
601-700	739	254	nf	0	0	0	0		0	0	0	
	743	211	nf	0	0	0	0		0	0	0	
	747	724	nf	0	0	0	0		0	0	0	
	750	556	nf	0	0	0	0		0	0	0	
601-700		1745	nf	0	0	0	0	0	0	0	0	
701-800	740	264	nf	0	0	0	0		0	0	0	
	744	280	nf	0	0	0	nf		0	0	0	
	751	229	nf	0	0	0	nf		0	0	0	
701-800		773	nf	0	0	0	0	0	0	0	0	
total strata fished > 200 fathoms			160	0	1209	235	294	4248	1118	191	588	34
total all strata fished offshore			5275	6140	10200	5039	13904	19318	19824	7652	5438	5300
upper			7834	9799	19797	7148	56316	91155	28382	10721	8157	6675
t-value			2.145	2.306	2.447	2.07	12.71	12.71	2.12	2.12	2.201	2.09
1 STD all strata fished offshore			1193	1587	3922	1019	3337	5652	4037	1448	1235	658

nf Not all strata in the depth range hav been fished. Strata not fished in the greater than 200 fathom depth range have not been filled using a multiplicative model.

Table 23. Estimates of cod abundance (thousands) from surveys in inshore strata of divisions 3K and 3L in 1996-1998 and 2000-2004. Also shown are totals for offshore strata and for all strata fished.

Division 3K

Stratum depth (meters)	Stratum number	Area sq. nautical miles	WT 196-199 TELEOST 40-42 1996	WT 217 TELEOST 55-57 1997	WT 233 1998	WT 321-323 Tel 342-343 2000	WT 372-376 WT 398 2001	WT 428-431 2002	WT 515 TEL 514 2003	Tel 539-542 WT 588 2004-5
Mean survey date			14-Nov-96	18-Nov-97	2-Dec-98	28-Nov-00	15-Nov-01	6-Dec-02	13-Jan-04	14-Dec-04
						abundance				
101-200	608	798	915	1061	1647	2023	3732	951	7191	1536
	612	445	510	92	367	184	284	153	1377	551
	616	250	103	52	206	103	209	52	79	59
201-300	609	342	436	329	155	188	588	518	2315	338
	611[3]	600	122	578	169	428	254	631	1826	275
	615	251	0	17	104	86	86	17	92	35
301-400	610	256	31	405	493	317	345	247	149	194
	614	263	16	0	18	0	0	0	0	36
401-500	613	30	0	0	12	7	0	0	2	4
total inshore strata			2134	2534	3171	3336	5498	2568	13032	3030
total offshore			18622	8450	15896	35774	28595	42934	21868	36049
total all strata fished			20756	10984	19067	39110	34093	45502	34899	39079
upper			25281	13883	23352	61173	41607	68034	41513	47477
t-value			2.048	2.101	2.1	2.57	2.12	2.2	2.306	2.13
STD all strata fished			2209	1380	2040	8585	3544	10242	2868	3943

Division 3L

Stratum depth (fathoms)	Stratum number	Area sq. nautical miles	Teleost 41 WT 196-198 1996	WT 213-217 TELEOST 57-58 1997	WT 233 1998	WT 321-323 Tel 342-343 2000	WT 372-376 WT 398 2001	WT 428-431 2002	WT488-489 WT 511 2003	WT 558-559 WT 587 Tel 540 2004
Mean survey date			2-Nov-96	27-Nov-97	28-Nov-98	28-Nov-00	15-Nov-01	12-Nov-02	18-Nov-04	5-Dec-04
						abundance				
16-30	784	268	1161	995	203	1419	4737	250	276	977
31-50	785	465	3998	1279	352	1567	2910	959	192	1983
51-100	786	84	12	97	532	58	56	116	1375	20
	787	613	42	84	4005	1288	201	422	12522	421
	788[1]	252	2409	323	144	1849	1387	156	2549	1562
	790	89	55	444	61	208	318	402	4440	631
	793	72	599	119	64	337	1362	594	1766	203
	794	216	609	97	104	nf	1997	1119	396	893
	797	98	20	27	101	440	162	150	620	329
	799	72	857	30	39	89	312	11	299	114
101-150	795	164	11	64	163	1277	429	654	14900	256
	791[2]	227		200	94	710	1102	281	687	734
101-200	789[1]	81	0	0	0	4	10	0	20	10
	791[2]	308	191	X	X	X	X	X	X	
	798	100	14	0	34	107	227	360	104	110
151-200	796	175	0	23	12	138	686	300	226	144
	800[2]	81		6	49	94	95	40	61	67
201-300	792	50	0	0	3	3	10	3	7	14
total inshore strata			9978	3788	5960	9588	16002	5817	40442	8467
total offshore			7066	11004	6628	32846	29017	11096	14448	18657
total all strata fished			17044	14792	12588	42435	45019	17024	54890	27124
upper			27958	19944	61095	62955	61291	22146	120325	35275
t-value			2.776	2.447	12.71	3.18	2.14	2.2	4.303	2.45
STD all strata fished			3932	2105	3816	6453	7604	2328	15207	3327

changes below were made before 1997 fall survey

[1] Area of stratum 788 was increased by 9 sq. n. mi and the area of stratum 789 was decreased by 9 sq.n. mi.

2 Stratum 791 in the 100-200 depth range was divided into two separate strata; 791 101-150
with area =227 sq. n. mi.and stratum 800 151-200 area = 81 sq. n.mi.

[3] Stratum 611 area was decreased by 27 sq. n. mi.

Table 24. Estimates of cod biomass (t) from surveys in inshore strata of divisions 3K and 3L in 1996-1998 and 2000-2004. Also shown are totals for offshore strata and for all strata fished.

Division 3K

Stratum depth (meters)	Stratum number	Area sq. nautical miles	WT 196-199 TELEOST 40-42	WT 217 TELEOST 55-57	WT 233	WT 321-323	WT 372-376 WT 398	WT 428-431	WT 515 TEL 514	Tel 539-542 WT 588
			1996	1997	1998	2000	2001	2002	2003	2004-5
Mean survey date			14-Nov-96	18-Nov-97	2-Dec-98	28-Nov-00	15-Nov-01	6-Dec-02	13-Jan-04	14-Dec-04
						biomass				
101-200	608	798	201	142	113	288	431	86	401	135
	612	445	111	3	18	7	20	8	36	71
	616	250	4	0	5	9	6	11	2	30
201-300	609	342	108	64	30	79	188	128	162	60
	611 [3]	600	25	129	9	136	83	118	82	20
	615	251	0	0	61	8	14	1	4	2
301-400	610	256	3	117	50	63	58	55	14	29
	614	263	2	0	33	0	0	0	0	3
401-500	613	30	0	0	1	1	0	0	0	1
total inshore strata			454	455	320	592	800	408	701	351
total offshore			5588	4020	7521	11994	9946	12523	6569	10375
total all strata fished			6039	4475	7843	12585	10746	12931	7270	10726
upper			7036	5583	10141	19889	13694	19174	9115	13740
t-value			2.032	2.11	2.23	2.45	2.14	2.18	2.306	2.36
STD all strata fished			491	525	1030	2981	1378	2864	800	1277

Division 3L

Stratum depth (fathoms)	Stratum number	Area sq. nautical miles	Teleost 41 WT 196-198	√T 213-217 TELEOST 57-58	WT 233	WT 321-323	WT 372-376 WT 398	WT 428-431	/T 488-489 WT 522	WT 558-559 WT 587 Tel 540
			1996	1997	1998	2000	2001	2002	2003	2004
Mean survey date			2-Nov-96	27-Nov-97	28-Nov-98	28-Nov-00	15-Nov-01	20-Dec-02	18-Nov-04	5-Dec-04
						biomass				
16-30	784	268	80	40	3	597	378	6	54	38
31-50	785	465	6627	1786	109	564	181	150	53	75
51-100	786	84	2	36	54	43	17	39	56	24
	787	613	135	61	105	214	28	264	794	117
	788 [1]	252	177	232	92	79	208	85	79	162
	790	89	56	222	24	67	53	181	161	156
	793	72	155	56	24	35	84	171	209	30
	794	216	84	122	31	nf	474	229	138	123
	797	98	11	13	24	25	8	25	19	28
	799	72	410	19	9	9	43	7	17	7
101-150	795	164	5	50	58	69	80	145	385	41
	791 [2]	227		154	53	274	626	148	224	252
101-200	789 [1]	81	0	0	0	1	2	0	5	1
	791 [2]	308	114	X	X	X	X	X	X	X
	798	100	47	0	11	33	53	173	26	16
151-200	796	175	0	8	2	34	136	85	11	53
	800 [2]	81		2	60	21	34	14	35	30
201-300	792	50	0	0	3	1	7	1	1	1
total inshore strata			7903	2801	662	2066	2412	1719	2266	1154
total offshore			6140	10200	5039	19318	19824	7652	5438	5300
total all strata fished			14044	13000	5702	21386	22236	9099	7705	6454
upper			92802	19797	7837	93444	30832	12376	10466	7923
t-value			12.706	2.447	2.06	12.71	2.11	2.11	2.179	2.07
STD all strata fished			6198	2778	1036	5669	4074	1553	1267	710

changes below were made before 1997 fall survey

[1] Area of stratum 788 was increased by 9 sq. n. mi and the area of stratum 789 was decreased by 9 sq.n. mi.

2 Stratum 791 in the 100-200 depth range was divided into two separate strata; 791 101-150 with area =227 sq. n. mi.and stratum 800 151-200 area = 81 sq. n.mi.

[3] Stratum 611 area was decreased by 27 sq. n. mi.

Table 25. Summary of estimates of cod abundance (thousands) and biomass (t) for all strata fished in 1983-2004. Data from 1983-1994 are in Campelen equivalent units and data from 1995-2004 are in actual Campelen units.

DIVISION	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
Total abundance all strata fished												
2J	1,124,317	743,328	615,304	1,249,871	410,936	509,360	647,797	264,807	365,191	31,560	17,082	8,373
3K	447748	451,517	208,952	891,302	284,648	457,191	1,307,523	972,029	649,529	61,886	37,265	9,612
3L	428505	995,804	464,291	358,606	325,352	256,383	172,299	396,008	145,682	148,719	47,809	4,678
2J3KL	2,000,570	2,190,649	1,288,547	2,499,779	1,020,936	1,222,934	2,127,619	1,632,844	1,160,402	242,165	102,156	22,663
Total biomass all strata fished												
2J	722,491	557,302	472,214	1,287,042	492,144	599,436	425,874	131,943	170,892	13,096	5,238	2,877
3K	374,634	370,356	209,686	964,600	303,212	216,734	830,045	645,136	649,529	35,604	14,598	4,437
3L	278,412	479,606	369,689	387,438	284,230	274,553	160,688	406,730	123,108	128,048	30,694	3,149
2J3KL	1,375,537	1,407,264	1,051,589	2,639,080	1,079,586	1,090,723	1,416,607	1,183,809	943,529	176,748	50,530	10,463
Percent abundance												
2J	56	34	48	50	40	42	30	16	31	13	17	37
3K	22	21	16	36	28	37	61	60	56	26	36	42
3L	21	45	36	14	32	21	8	24	13	61	47	21
Percent biomass												
2J	53	40	45	49	46	55	30	11	18	7	10	27
3K	27	26	20	37	28	20	59	54	69	20	29	42
3L	20	34	35	15	26	25	11	34	13	72	61	30

DIVISION	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total abundance all strata fished										
2J	14,654	13,300	7,020	6,636	6,129	7,567	7,040	10,427	9,945	9,536
3K	23,954	20,756	10,984	19,067	29,433	39,110	34,093	45,212	34,889	39,079
3L	8,013	17,044	14,774	12,588	25,514	42,435	45,019	17,024	54,890	27,124
2J3KL	46,621	51,100	32,778	38,291	61,076	89,112	86,152	72,663	99,724	75,739
Total biomass all strata fished										
2J	3,067	4,298	3,662	4,483	2,590	3,098	2647	4270	3248	4953
3K	4,978	6,039	4,475	7,842	12,519	12,585	10746	12854	7270	10,726
3L	5,275	14,044	13,000	5,701	13,904	21,386	22236	9099	7705	6454
2J3KL	13,320	24,381	21,137	18,026	29,013	37,069	35,629	26,223	18,223	22,133
Percent abundance										
2J	31	26	21	17	10	8	8	14	10	13
3K	51	41	34	50	48	44	40	62	35	52
3L	17	33	45	33	42	48	52	23	55	36
Percent biomass										
2J	23	18	17	25	9	8	7	16	18	22
3K	37	25	21	44	43	34	30	49	40	48
3L	40	58	62	32	48	58	62	35	42	29

Table 26. Summary of estimates of cod abundance (thousands) and biomass (t) for divisions 2J, 3K and 3L separately and combined in 1995-2004. Strata are aggregated into offshore index strata; those strata deeper than the offshore index strata and seaward of them; and those strata inshore of the offshore index strata. There are no inshore strata in Division 2J.

Division	Grouping	Abundance (thousands)									
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2J	index	12,305	13,081	6,936	6,636	6,074	7,516	7,033	9,534	9,315	9,503
	offshore deep	2,350	219	84	0	55	51	7	893	129	33
	total	14,654	13,300	7,020	6,636	6,129	7,567	7,040	10,427	9,444	9,536
3K	index	23,200	18,550	8,428	15,612	29,308	35,774	28,535	41,853	19,908	34,468
	offshore deep	754	72	22	285	124	0	60	792	1,962	1,581
	inshore	**nf**	2,133	2,534	3,171	**nf**	3,336	5,498	2,569	13,032	3,030
	total	23,954	20,755	10,984	19,068	29,432	39,110	34,093	45,214	34,902	39,079
3L	index	7,735	7,067	9,859	6,454	25,281	29,010	27,724	10,984	13,638	18,605
	offshore deep	280	0	1,144	173	233	3,837	1,293	112	811	53
	inshore	**nf**	9,978	3,770	5,960	**nf**	9,588	16,002	5,817	40,442	8,467
	total	8,015	17,045	14,773	12,587	25,514	42,435	45,019	16,913	54,891	27,125
2J3KL	index	43,240	38,698	25,223	28,702	60,663	72,300	63,292	62,371	42,861	62,576
	offshore deep	3,384	291	1,250	458	412	3,888	1,360	1,797	2,902	1,667
	inshore	**nf**	12,111	6,304	9,131	**nf**	12,924	21,500	8,386	53,474	11,497
	total	46,624	51,100	32,777	38,291	61,075	89,112	86,152	72,554	99,237	75,740

Division	Grouping	Biomass (t)									
		1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2J	index	2,312	4,261	3,609	4,483	2,527	3,082	2,646	3,680	3,065	4,921
	offshore deep	755	36	52	0	63	16	1	588	183	32
	total	3,067	4,298	3,662	4,483	2,590	3,098	2,647	4,268	3,248	4,953
3K	index	4,578	5,457	3,978	7,280	12,230	11,994	9,890	11,889	4,912	9,609
	offshore deep	400	131	42	242	289	0	56	557	1,657	766
	inshore	**nf**	454	455	320	**nf**	592	800	408	701	351
	total	4,978	6,042	4,475	7,842	12,519	12,586	10,746	12,854	7,270	10,726
3L	index	5,115	6,140	8,991	4,804	13,611	15,070	18,706	7,460	4,849	5,266
	offshore deep	160	0	1,209	235	294	4,282	1,118	191	588	34
	inshore	**nf**	7,903	2,801	662	**nf**	2,066	2,412	1,719	2,266	1,154
	total	5,275	14,043	13,001	5,701	13,905	21,418	22,236	9,370	7,703	6,454
2J3KL	index	12,005	15,858	16,578	16,567	28,368	30,146	31,242	23,029	12,826	19,796
	offshore deep	1,315	167	1,303	477	646	4,298	1,175	1,336	2,428	832
	inshore	**nf**	8,357	3,256	982	**nf**	2,658	3,212	2,127	2,967	1,505
	total	13,320	24,382	21,137	18,026	29,014	37,102	35,629	26,492	18,221	22,133

Table 27. Autumn bottom-trawl mean number per tow at age in offshore index strata adjusted for missing strata (1983-2004). The 2J3KL total is the mean of the divisional means, weighted by the divisional survey areas.

2J

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.01	0.02	0.00	0.33	0.74	0.00
1	46.58	7.57	1.71	0.65	1.46	20.52	4.86	2.75	0.37	0.00	0.00	0.18	2.46	0.52	0.00	0.10	0.21	0.57	0.16	0.43	0.66	0.38
2	147.86	41.01	14.01	18.71	3.03	17.69	108.44	13.80	11.17	0.68	3.22	1.21	1.24	2.15	0.41	0.19	0.79	0.66	0.69	0.76	0.47	1.22
3	61.64	86.28	48.03	39.16	8.12	10.83	33.77	46.34	19.04	4.45	1.03	0.83	0.80	1.24	1.42	0.72	0.56	0.77	1.25	0.8	0.79	0.70
4	61.08	38.75	74.50	97.79	12.11	12.14	16.27	12.48	60.31	1.70	1.05	0.34	0.31	0.49	0.39	0.89	0.30	0.45	0.19	0.78	0.31	0.58
5	25.59	53.27	28.44	153.27	50.67	16.35	10.85	4.79	14.89	3.29	0.32	0.15	0.08	0.13	0.11	0.29	0.17	0.04	0.06	0.10	0.13	0.24
6	10.44	14.98	27.11	68.45	43.15	41.46	12.35	2.39	1.73	0.31	0.27	0.01	0.02	0.02	0.00	0.04	0.00	0.04	0.01	0.01	0.02	0.06
7	4.87	2.87	9.75	29.99	9.98	42.71	17.99	1.44	0.70	0.01	0.02	0.02	0.00	0.02	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00
8	12.46	1.83	1.35	10.84	6.58	6.93	11.13	2.35	0.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
9	5.05	3.46	0.83	0.70	2.64	4.27	1.45	1.08	0.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10	2.87	1.49	1.14	0.64	0.41	2.06	0.77	0.23	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
11	0.58	0.54	0.39	0.55	0.04	0.28	0.35	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.04	0.12	0.17	0.29	0.16	0.11	0.12	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.03	0.02	0.03	0.07	0.06	0.08	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.02	0.00	0.00	0.02	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	379.11	252.19	207.46	421.13	138.45	175.48	218.36	87.76	109.11	10.44	5.91	2.74	4.96	4.57	2.33	2.24	2.04	2.55	2.37	3.21	3.12	3.18

3K

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.08	0.15	0.28	0.71	0.05	0.04	0.54	0.03
1	22.84	8.27	0.28	7.91	7.35	37.54	36.91	22.21	0.59	0.65	0.28	0.20	2.77	0.70	0.07	1.13	1.07	2.61	1.46	2.09	2.35	2.58
2	32.49	32.45	5.07	18.35	6.63	29.28	111.95	32.45	15.74	2.85	4.67	0.39	1.56	2.28	0.92	0.80	2.71	2.33	2.22	5.19	0.88	4.04
3	27.87	24.34	13.32	21.13	8.34	18.49	58.16	83.98	23.97	4.12	2.24	1.16	0.98	1.20	0.85	0.92	2.01	2.24	2.37	2.03	0.85	1.10
4	15.09	22.21	12.39	65.26	10.01	8.40	44.92	48.74	70.05	2.33	1.27	0.38	0.34	0.34	0.20	0.59	0.87	1.17	0.71	0.92	0.27	0.66
5	17.24	11.98	10.93	56.87	17.27	6.92	25.69	23.11	37.29	4.01	0.30	0.14	0.10	0.10	0.09	0.20	0.36	0.27	0.30	0.21	0.10	0.17
6	4.39	8.97	4.13	29.01	11.21	7.54	17.17	12.35	9.09	1.16	0.34	0.02	0.02	0.00	0.00	0.06	0.03	0.05	0.03	0.02	0.00	0.04
7	2.58	3.12	3.23	13.32	4.17	3.70	14.93	7.74	2.80	0.16	0.09	0.03	0.00	0.01	0.00	0.05	0.02	0.01	0.00	0.00	0.00	0.02
8	4.26	1.41	0.86	6.66	2.67	1.00	7.06	7.62	1.03	0.03	0.01	0.02	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01
9	2.98	2.12	0.65	2.41	1.21	0.44	2.54	2.35	0.56	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00
10	0.91	1.06	0.55	0.64	0.52	0.22	1.41	0.68	0.24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
11	0.22	0.34	0.40	0.79	0.21	0.04	0.65	0.22	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.12	0.11	0.09	0.58	0.08	0.04	0.16	0.06	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
13	0.02	0.05	0.01	0.09	0.06	0.01	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.01	0.02	0.00	0.07	0.02	0.02	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	131.02	116.45	51.91	223.09	69.75	113.64	321.74	241.51	161.39	15.31	9.20	2.34	5.82	4.63	2.21	3.91	7.36	9.39	7.16	10.50	4.99	8.66

(cont'd)

Table 27 (cont'd). Autumn bottom-trawl mean number per tow at age in offshore index strata adjusted for missing strata (1983-2002). The 2J3KL total is the mean of the divisional means, weighted by the divisional survey areas.

3L

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.32	0.30	0.04	0.03	0.03	0.17	0.27
1	17.62	7.68	0.15	1.03	3.87	1.26	0.54	0.82	1.06	0.08	0.00	0.00	0.11	0.04	0.07	0.14	0.79	1.18	0.67	0.30	1.54	0.98
2	27.24	75.48	11.11	9.71	22.54	12.57	5.36	6.54	5.27	3.25	1.66	0.19	0.34	0.21	0.64	0.17	1.51	1.59	1.66	0.90	0.32	2.64
3	40.89	56.42	32.05	9.02	7.70	13.43	12.73	22.12	5.02	8.14	2.44	0.28	0.52	0.36	0.61	0.32	1.86	1.62	1.49	0.37	0.40	0.33
4	9.53	35.05	24.62	22.23	6.96	4.08	7.03	24.38	7.89	7.96	2.46	0.23	0.27	0.43	0.27	0.17	0.20	0.98	0.95	0.31	0.13	0.12
5	9.21	6.44	13.18	13.13	10.93	5.57	2.17	11.06	5.59	5.64	0.79	0.09	0.15	0.19	0.15	0.04	0.15	0.31	0.45	0.18	0.06	0.08
6	1.50	10.12	5.23	10.20	6.81	5.91	2.30	5.29	2.66	3.07	0.32	0.04	0.11	0.09	0.04	0.03	0.08	0.09	0.10	0.05	0.03	0.03
7	1.45	1.48	3.04	2.97	2.86	4.19	2.20	3.21	0.44	0.79	0.05	0.02	0.03	0.05	0.07	0.01	0.01	0.03	0.02	0.01	0.01	0.02
8	2.36	1.02	0.57	2.09	1.10	1.86	0.81	2.38	0.22	0.06	0.01	0.00	0.01	0.01	0.09	0.05	0.02	0.03	0.01	0.00	0.00	0.01
9	1.26	0.88	0.69	0.80	0.85	0.90	0.56	1.31	0.23	0.04	0.00	0.00	0.00	0.01	0.01	0.02	0.03	0.01	0.02	0.00	0.00	0.01
10	0.44	0.94	0.35	0.32	0.09	0.46	0.17	0.51	0.09	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
11	0.13	0.38	0.25	0.41	0.12	0.12	0.06	0.24	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.06	0.00	0.01	0.00
12	0.06	0.22	0.11	0.22	0.19	0.10	0.03	0.15	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00
13	0.02	0.04	0.04	0.09	0.10	0.12	0.03	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
14	0.05	0.03	0.01	0.03	0.03	0.07	0.04	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00
15	0.00	0.03	0.01	0.03	0.01	0.03	0.01	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.01	0.03	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.02	0.01	0.01	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	111.87	196.27	91.42	72.30	64.19	50.68	34.04	78.19	28.59	29.08	7.73	0.85	1.54	1.39	1.95	1.28	4.98	5.88	5.48	2.18	2.69	4.49

2J3KL

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.18	0.22	0.26	0.03	0.11	0.43	0.12
1	26.49	7.85	0.58	3.23	4.44	18.12	13.75	8.44	0.73	0.25	0.09	0.11	1.58	0.38	0.05	0.46	0.74	1.51	0.81	0.93	1.59	1.37
2	58.68	52.62	9.81	14.81	12.42	19.41	66.33	16.98	10.22	2.48	3.05	0.51	0.97	1.38	0.68	0.39	1.73	1.61	1.61	2.30	0.54	2.76
3	41.65	53.05	29.73	20.48	8.02	14.48	33.08	48.74	14.80	5.89	2.03	0.71	0.74	0.86	0.89	0.62	1.59	1.62	1.72	1.03	0.65	0.68
4	24.08	31.67	32.81	55.20	9.25	7.51	21.96	29.59	41.55	4.54	1.72	0.31	0.30	0.41	0.28	0.49	0.45	0.91	0.68	0.63	0.22	0.41
5	15.93	19.82	16.18	62.23	22.83	8.67	12.16	13.54	18.47	4.52	0.51	0.12	0.12	0.15	0.12	0.15	0.23	0.23	0.30	0.17	0.09	0.15
6	4.67	10.93	10.25	30.82	17.22	15.21	9.74	6.93	4.58	1.75	0.31	0.03	0.06	0.04	0.02	0.04	0.04	0.06	0.05	0.03	0.02	0.04
7	2.67	2.37	4.76	13.08	5.05	13.51	10.34	4.29	1.29	0.39	0.06	0.02	0.01	0.03	0.03	0.02	0.01	0.02	0.01	0.00	0.00	0.02
8	5.48	1.35	0.86	5.77	2.97	2.82	5.44	4.12	0.54	0.04	0.01	0.01	0.00	0.00	0.04	0.02	0.01	0.01	0.01	0.00	0.00	0.01
9	2.77	1.93	0.71	1.31	1.41	1.58	1.44	1.60	0.35	0.02	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.01	0.00	0.00	0.00
10	1.20	1.12	0.61	0.51	0.31	0.77	0.73	0.50	0.15	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00
11	0.27	0.41	0.33	0.57	0.13	0.13	0.33	0.19	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
12	0.07	0.16	0.12	0.36	0.15	0.08	0.10	0.10	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00
13	0.02	0.04	0.03	0.09	0.08	0.07	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
14	0.03	0.02	0.00	0.04	0.03	0.04	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
15	0.00	0.02	0.00	0.01	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
16	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
17	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
21	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
TOTAL	184.04	183.38	106.79	208.52	84.33	102.43	175.50	135.09	92.76	19.89	7.77	1.81	3.79	3.25	2.10	2.21	5.05	6.23	5.28	5.21	3.56	5.56

Table 28. Autumn bottom-trawl mean catch (number) per tow at age in inshore strata in 3K and 3L, and 3K and 3L combined, in 1996-1998 and 2000-2004. For each year and Division, an age-length key was constructed from sampling conducted both inshore and offshore, and this key was applied to the catch rate at length from the inshore strata in the appropriate year and Division.

	3K									3L								
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.04	0.70	0.64		0.48	0.15	0.46	7.03	0.12	0.04	1.53	6.54		2.34	1.79	1.69	14.00	5.71
1	1.87	2.15	4.76		3.27	7.38	2.73	21.32	4.09	10.28	1.31	4.77		10.83	23.63	3.77	74.93	7.61
2	1.70	2.19	1.33		2.43	2.55	2.29	0.56	2.25	5.67	1.39	1.47		6.20	7.86	5.66	2.60	5.52
3	0.76	0.49	0.31		1.15	1.79	0.19	0.28	0.33	2.50	1.75	0.57		2.90	2.07	1.39	2.30	0.44
4	0.33	0.05	0.08		0.10	0.51	0.09	0.27	0.07	2.12	1.54	0.34		1.18	1.31	0.61	0.58	0.18
5	0.10	0.07	0.04		0.12	0.07	0.05	0.07	0.01	1.49	0.86	0.08		0.32	0.57	0.30	0.15	0.18
6	0.02	0.00	0.02		0.00	0.00		0.00		2.06	0.12	0.10		0.12	0.09	0.08	0.02	0.05
7		0.08	0.02			0.00		0.00		1.10	0.15	0.02		0.09	0.03	0.00	0.01	0.05
8										0.54	0.11	0.02		0.07	0.01	0.02	0.00	0.06
9										0.48	0.10	0.02		0.03	0.04	0.03	0.01	0.01
10										0.11				0.00	0.02	0.01	0.00	0.01
11														0.01	0.03	0.00	0.00	
12																0.00	0.00	
13																0.00	0.03	
14																0.00		
15																0.01		
Total	4.82	5.73	7.20		7.55	12.45	5.81	29.53	6.87	26.39	8.86	13.93		24.09	37.45	13.57	94.63	19.82

	3KL								
Age	1996	1997	1998	1999	2000	2001	2002	2003	2004
0	0.04	1.11	3.53		1.39	0.95	1.06	10.44	2.86
1	5.99	1.74	4.76		6.97	15.34	3.24	47.58	5.81
2	3.64	1.80	1.40		4.28	5.15	3.94	1.56	3.85
3	1.61	1.11	0.44		2.01	1.93	0.78	1.27	0.38
4	1.21	0.78	0.21		0.63	0.90	0.34	0.42	0.12
5	0.78	0.46	0.06		0.22	0.31	0.17	0.11	0.09
6	1.02	0.06	0.06		0.06	0.04	0.04	0.01	0.02
7	0.54	0.11	0.02		0.04	0.01	0.00	0.00	0.02
8	0.26	0.05	0.01		0.03	0.00	0.01	0.00	0.03
9	0.24	0.05	0.01		0.01	0.02	0.01	0.00	0.00
10	0.05	0.00	0.00		0.00	0.01	0.00	0.00	0.00
11	0.00	0.00	0.00		0.00	0.01	0.00	0.00	0.00
12	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00		0.00	0.00	0.00	0.01	0.00
14	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
15	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00
Total 0+	15.39	7.26	10.50		15.65	24.70	9.61	61.42	13.21
Total 1+	15.35	6.16	6.97		14.26	23.74	8.55	50.98	10.36
Total 5+	2.89	0.73	0.16		0.37	0.42	0.25	0.14	0.18

Table 29. Estimates of cod abundance (thousands) from spring surveys in Division 3L in 1985-2004 in depths <= 200 fathoms. The 1985-1995 data are in Campelen equivalent units and the 1996-2004 data are in actual Campelen units.

Depth		Stratum	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT	WT
range	Stratum	area	28-30	48	59-60	70-71	83	96	106-107	119-122	137-138	152-154	168-170
(fath)	number	sq mi.	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Mean Date			7-May-85	16-May-86	23-May-87	15-May-88	18-May-89	26-May-90	20-May-91	24-May-92	31-May-93	1-Jun-94	6-Jun-95
31-50	350	2071	52111	14685	17275	90559	24682	8018	748	414	32	0	0
	363	1780	25710	24878	27778	46453	21738	3918	1504	789	306	0	0
	371	1121	29035	2262	3503	3115	4086	3315	32260	123	93	0	0
	372	2460	83387	37973	21684	37778	17675	2852	541	34	62	0	0
	384	1120	591	4442	5238	1078	1566	193	270	0	31	0	0
51-100	328	1519	5642	2113	2866	522	0	3194	1846	0	453	0	0
	341	1574	17899	5678	14651	20425	7984	2436	469	0	0	736	0
	342	585	3702	1127	1328	402	5445	523	0	1314	322	188	0
	343	525	9076	4496	1300	2744	8065	891	2239	1565	614	361	361
	348	2120	38479	16258	21435	19062	12022	6575	73	227	109	365	510
	349	2114	32383	21146	12795	14649	25115	10986	1066	711	905	0	0
	364	2817	38614	10691	21365	13718	24050	4456	1902	0	97	0	0
	365	1041	22237	6272	15466	15931	8306	2076	322	36	0	0	0
	370	1320	57062	2973	16783	8861	18226	1219	34833	0	91	0	0
	385	2356	22038	997	1886	5736	25360	7808	17055	97	383	0	0
	390	1481	2513	484	320	0	891	41	122	34	102	0	0
101-150	344	1494	10481	21142	3288	4110	31503	4864	986	1165	514	0	822
	347	983	7221	14225	7077	11981	6694	913	1690	34	304	0	0
	366	1394	207996	63401	41749	8885	33414	15053	12651	415	384	0	0
	369	961	58351	33952	16392	28158	13021	6134	3701	198	0	0	0
	386	983	46544	12395	14766	26504	37547	32048	32544	68	54	0	0
	389	821	70767	10458	8150	11181	13214	5788	9524	75	0	0	56
	391	282	5916	4442	2812	1494	2819	45154	6750	0	0	0	0
151-200	345	1432	16153	41480	60278	19723	29548	14232	3217	492	525	2167	197
	346	865	10650	63279	18991	11602	9965	145882	10812	1577	833	278	476
	368	334	10154	10912	14289	414	4150	51551	4992	10866	1355	184	23
	387	718	131461	22816	691	2272	16336	241169	93995	23145	6288	0	560
	388	361	2955	11496	25	1738	1606	36947	10809	4618	2235	0	174
	392	145	6642	1855	20	2094	645	22130	4618	40	479	0	110
total strata fished <= 200 fath			1025769	468328	374201	411190	405673	680365	263087	48038	16569	4278	3289
ADJUSTED			1025770	468328	374201	411189	405673	680366	291539	48037	16571	4279	3289
upper			1335489	548125	506851	521077	475378	1169116	395962	105950	29261	7094	5694
t-value			2.16	2.037	2.571	2.16	2.04	2.776	2.365	4.303	3.182	2.201	2.306
1 STD strata fished <= 200 fath			143389	39174	51595	50874	34169	176063	56184	13459	3989	1279	1043

[1] **Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.**

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Table 29 (cont'd). Estimates of cod abundance (thousands) from spring surveys in Division 3L in 1985-2004 in depths <= 200 fathoms. The 1985-1995 data are in Campelen equivalent units and the 1996-2004 data are in actual Campelen units.

Depth range (fath) Mean Date	Stratum number	Stratum area sq mi.	WT 189-191 1996 14-Jun-96	WT 207-208 1997 15-Jun-97	WT 223-224 1998 19-Jun-98	WT 240-241 1999 22-Jun-99	WT 317-318 2000 17-Jun-00	WT 365-370 2001 11-Jun-01	WT 422-424 2002 10-Jun-02	WT 479-482 2003 15-Jun-03	WT 546-549 2004
31-50	350	2071	412	122	47	1268	71	297	81	163	285
	363	1780	111	0	0	281	420	82	0	41	122
	371	1121	0	0	0	0	0	39	39	0	39
	372	2460	217	0	42	602	1203	42	0	42	381
	384	1120	102	0	0	0	77	0	0	39	0
51-100	328	1519	90	35	125	376	1254	139	84	507	79
	341	1574	340	1728	172	577	476	909	43	173	433
	342	585	0	121	80	121	322	241	40	80	201
	343	525	36	0	217	108	72	36	0	0	144
	348	2120	151	65	328	231	109	0	167	333	232
	349	2114	424	145	73	646	332	249	166	249	291
	364	2817	234	49	106	201	155	254	129	0	43
	365	1041	58	0	0	95	0	48	48	0	95
	370	1320	61	0	0	0	36	0	0	0	0
	385	2356	30	0	0	46	81	46	41	0	81
	390	1481	59	0	0	150	0	122	0	0	0
101-150	344	1494	565	300	355	509	260	392	485	870	575
	347	983	0	34	203	336	135	676	45	180	90
	366	1394	245	447	141	133	1630	230	3545	652	1432
	369	961	30	33	66	39	132	196	206	264	118
	386	983	0	30	34	265	406	260	45	0	40
	389	821	0	33	33	113	1412	1016	75	0	376
	391	282	0	0	0	19	0	78	19	39	0
151-200	345	1432	773	972	460	1121	2151	2053	2403	906	2430
	346	865	487	579	71	670	948	996	2248	1282	363
	368	334	402	158	46	92	863	1330	578	347	523
	387	718	142	1037	1635	684	3556	307	285	198	1054
	388	361	84	0	72	372	564	695	290	770	221
	392	145	111	0	80	41	195	150	748	140	70
total strata fished <= 200 fath			5166	5888	4386	9096	16860	10884	11810	7277	9718
ADJUSTED			5164	5888	4386	9096	16860	10884	11810	7277	9718
upper			6223	10529	10169	11449	52643	14422	16092	9317	14260
t-value			2.023	2.447	4.30	2.05	12.71	2.31	2.33	2.12	2.26
1 STD strata fished <= 200 fath			522	1897	1345	1148	2815	1532	1838	962	2010

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[1] **Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.**

Table 30. Estimates of cod biomass (t) from spring surveys in Division 3L in 1985-2004 in depths <= 200 fathoms. The 1985-1995 data are in Campelen equivalent units and the 1996-2004 data are in actual Campelen units.

Depth range (fath) Mean Date	Stratum number	Stratum area sq mi.	WT 28-30 1985 7-May	WT 48 1986 16-May	WT 59-60 1987 23-May	WT 70-71 1988 15-May	WT 83 1989 18-May	WT 96 1990 26-May	WT 106-107 1991 20-May	WT 119-122 1992 24-May	WT 137-138 1993 31-May	WT 152-154 1994 1-Jun	WT 168-170 1995 6-Jun
31-50	350	2071	61578	29203	32147	116896	41232	14057	1636	315	35	0	0
	363	1780	29020	26035	38567	49356	30897	12388	2289	526	111	0	0
	371	1121	29516	5426	7039	6714	7089	5149	44086	36	37	0	0
	372	2460	87371	39729	37570	52582	31350	12849	1553	112	96	0	0
	384	1120	557	7038	7416	1515	1308	1029	653	0	71	0	0
51-100	328	1519	568	1708	3573	879	0	5670	180	0	243	0	0
	341	1574	11711	12988	20564	32613	9121	5854	376	0	0	65	0
	342	585	1445	2669	1041	600	1400	1035	0	66	64	33	0
	343	525	2833	3087	1981	2878	3927	255	207	70	52	46	42
	348	2120	17699	22373	52505	40777	18921	6772	273	37	43	47	87
	349	2114	31189	44296	22988	34821	50689	3835	836	125	158	0	0
	364	2817	21165	17309	34942	26822	34642	15553	1228	0	124	0	0
	365	1041	5934	6427	19818	18776	10427	2210	154	81	0	0	0
	370	1320	21097	6523	16440	12422	15405	1288	29422	0	74	0	0
	385	2356	6499	894	2131	4572	10414	2269	13797	95	256	0	0
	390	1481	874	764	891	0	520	129	604	58	83	0	0
101-150	344	1494	1926	16730	1768	2949	15613	696	103	167	83	0	95
	347	983	6837	19615	8729	17943	5283	669	199	35	83	0	0
	366	1394	111212	62264	42788	15741	32354	12386	**6899**	111	121	0	0
	369	961	36262	27273	23039	37815	18342	7693	3547	78	0	0	0
	386	983	13632	5635	10490	10110	19985	59202	17066	154	66	0	0
	389	821	21457	3540	2864	3284	3509	1529	1654	114	0	0	36
	391	282	1380	1944	797	316	513	6018	1220	0	0	0	0
151-200	345	1432	6738	39168	63833	24326	40145	5601	466	332	120	437	108
	346	865	1650	48302	18827	13037	10501	136822	**4834**	613	302	86	91
	368	334	4237	13403	16324	1286	5297	41814	3318	4684	590	120	22
	387	718	60424	16437	508	1609	8453	101468	37550	18465	2329	0	227
	388	361	1143	5814	27	695	676	35162	4031	1078	1431	0	60
	392	145	5177	1121	11	573	251	6418	1107	22	63	0	37
total strata fished <= 200 fathoms			601128	487714	489618	531905	428264	505819	164236	27374	6633	834	805
ADJUSTED			601131	487715	489618	531907	428264	505820	179288	27374	6635	834	805
upper			765217	563448	632377	669157	490124	742119	286846	71593	14791	1310	1234
t-value			2.101	2.02	2.447	2.16	1.998	2.228	2.447	4.303	4.303	2.365	2.179
1 STD strata fished <= 200 fathoms			78100	37492	58340	63543	30961	106059	50106	10276	1896	201	197

[1] Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.

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Table 30 (cont'd). 30. Estimates of cod biomass (t) from spring surveys in Division 3L in 1985-2004 in depths <= 200 fathoms. The 1985-1995 data are in Campelen equivalent units and the 1996-2004 data are in actual Campelen units.

Depth range (fath) Mean Date	Stratum number	Stratum area sq mi.	WT 189-191 1996 14-Jun	WT 207-208 1997 15-Jun	WT 223-224 1998 19-Jun-98	WT 240-241 1999 22-Jun	WT 317-318 2000 17-Jun	WT 365-370 2001 11-Jun	WT 422-424 2002 10-Jun	WT 479-482 2003 15-Jun	WT 546-549 2004
31-50	350	2071	359	135	6	3708	17	621	28	11	22
	363	1780	61	0	0	693	193	1	0	3	1275
	371	1121	0	0	0	0	0	25	1	0	1
	372	2460	83	0	0	598	392	4	0	355	8
	384	1120	65	0	0	0	20	0	0	1	0
51-100	328	1519	6	5	115	739	89	37	3	129	61
	341	1574	127	4497	9	1238	96	549	3	16	644
	342	585	0	346	8	209	23	9	2	9	13
	343	525	9	0	36	254	27	0.361	0	0	11
	348	2120	53	13	536	395	10	0	14	16	20
	349	2114	303	419	101	1903	615	26	5	113	34
	364	2817	20	11	225	683	43	15	3	0	3
	365	1041	5	0	0	178	0	17	1	0	8
	370	1320	6	0	0	0	1	0	0	0	0
	385	2356	4	0	0	227	2	4	42	0	3
	390	1481	31	0	0	6	0	5	0	0	0
101-150	344	1494	111	115	124	496	152	126	71	307	128
	347	983	0	8	150	52	9	182	3	32	13
	366	1394	104	173	61	83	210	25	292	130	396
	369	961	16	3	20	11	218	159	10	60	93
	386	983	0	16	183	94	311	131	10	0	25
	389	821	0	9	25	16	587	440	83	0	137
	391	282	0	0	0	4	0	41	2	3	0
151-200	345	1432	149	294	159	359	956	725	605	327	349
	346	865	178	238	32	407	582	260	558	644	215
	368	334	148	96	8	63	499	417	100	91	225
	387	718	84	303	1199	578	2057	191	112	34	325
	388	361	12	0	27	167	251	176	147	497	67
	392	145	18	0	23	30	19	74	332	13	16
total strata fished <= 200 fathoms			1951	6667	3048	12962	7378	4262	2428	2794	4094
ADJUSTED			1952	6667	3048	12962	7378	4262	2428	2794	4094
upper			2468	17631	6102	18566	30307	6164	3040	4093	7427
t-value			2.017	2.571	3.18	2.16	12.71	2.14	2.18	28	2.36
1 STD strata fished <= 200 fathoms			256	4264	960	2594	1804	889	281	46	1412

[1] **Not all strata in the depth range have been fished. Strata not fished in the <= 200 fathom depth range have been filled using a multiplicative model using data to 1992. Std are for strata fished in the depth range.**

Table 31. Estimates of cod abundance (thousands) and biomass (t) from spring surveys in Division 3L in 1985-2004 in depths > 200 fathoms. The 1985-1995 data are in Campelen equivalent units and the 1996-2004 data are in actual Campelen units.

Depth range (fath)	Stratum number	Stratum area nautical miles	WT 28-30 1985	WT 48 1986	WT 59-60 1987	WT 70-71 1988	WT 83 1989	WT 96 1990	WT 106-107 1991	WT 119-122 1992	WT 137-138 1993	WT 152-154 1994	WT 168-170 1995
Mean Date			7-May	16-May	23-May	15-May	18-May	26-May	20-May	24-May	31-May	1-Jun	6-Jun
abundance													
201-300	729	186	102	nf	nf	nf	nf	nf	141	3876	192	77	0
	731	216	30	nf	nf	nf	nf	nf	3046	267	416	9701	0
	733	468	1674	nf	nf	nf	nf	nf	7339	2672	880	1513	483
	735	272	94	nf	nf	nf	nf	nf	nf	92905	0	6080	673
301-400	730	170	0	nf	nf	nf	nf	nf	0	0	0	0	0
	732	231	0	nf	nf	nf	nf	nf	0	0	0	0	0
	734	228	0	nf	nf	nf	nf	nf	267	0	0	0	0
	736	175	0	nf	nf	nf	nf	nf	nf	60	0	0	0
401-500	737	227	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
	741	223	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
	745	348	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
	748	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
Total >200 fathoms			1900	0	0	0	0	0	10793	99780	1488	17371	1156
Total all strata fished			1027668	468328	374201	411190	405673	680365	273879	147819	18056	21649	4445
upper			1337409	548125	506851	521077	475378	1169116	407660	1331862	29180	148586	7460
t-value			2.16	2.037	2.571	2.16	2.04	2.776	2.365	12.706	2.776	12.706	2.365
1 STD all strata fished			143399	39174	51595	50874	34169	176063	56567	93188	4007	9990	1275
biomass													
201-300	729	186	78	nf	nf	nf	nf	nf	320	1683	78	29	0
	731	216	78	nf	nf	nf	nf	nf	1967	389	248	5913	0
	733	468	755	nf	nf	nf	nf	nf	6351	1959	345	556	219
	735	272	894	nf	nf	nf	nf	nf	nf	50199	0	3238	386
301-400	730	170	0	nf	nf	nf	nf	nf	0	0	0	0	0
	732	231	0	nf	nf	nf	nf	nf	0	0	0	0	0
	734	228	0	nf	nf	nf	nf	nf	437	0	0	0	0
	736	175	0	nf	nf	nf	nf	nf	nf	69	0	0	0
401-500	737	227	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
	741	223	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
	745	348	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
	748	159	nf	nf	nf	nf	nf	nf	nf	nf	nf	0	nf
Total >200 fathoms			1805	0	0	0	0	0	9075	54299	671	9736	605
Total all strata fished			602932	487714	489618	531905	428264	505819	173311	81673	7304	10570	1410
upper			767031	563448	632377	669157	490124	742119	296576	729549	15476	86302	7004
t-value			2.101	2.02	2.447	2.16	1.998	2.228	2.447	12.706	4.303	12.706	12.706
1 STD all strata fished			78105	37492	58340	63543	30961	106059	50374	50990	1899	5960	440

nf Not all strata in the depth range were fished. Strata not fished in the greater than 200 fathom depth range have not been filled using a multiplicative model.

cont'd

Table 31 (cont'd). Estimates of cod abundance (thousands) and biomass (t) from spring surveys in Division 3L in 1985-2004 in depths > 200 fathoms. The 1985-1995 data are in Campelen equivalent units and the 1996-2004 data are in actual Campelen units .

Depth range (fath) Mean Date	Stratum number	Stratum area nautical miles	WT 189-191 1996 14-Jun	WT 207-208 1997 15-Jun	WT 223-224 1998 19-Jun	WT 240-241 1999 22-Jun	WT 317-318 2000 17-Jun	WT 365-370 2001 11-Jun	WT 422-424 2002 10-Jun	WT 479-482 2003 15-Jun	WT 546-549 2004
abundance											
201-300	729	186	13	0	13	0	2240	171	50	280	0
	731	216	152	0	13	104	155	409	272	1398	0
	733	468	41	89	0	258	315	626	1094	5565	0
	735	272	5512	524	3480	35	580	3792	3138	3530	0
301-400	730	170	0	0	0	0	0	0	0	0	0
	732	231	0	0	0	0	0	0	0	0	0
	734	228	0	0	0	0	0	0	0	14	0
	736	175	0	0	0	0	0	0	0	0	0
401-500	737	227	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
	741	223	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
	745	348	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
	748	159	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
Total >200 fathoms			5718	613	3506	397	3290	4998	4554	10787	0
Total all strata fished			10884	6501	7892	9493	20150	15881	16364	18064	9718
upper			21527	11073	54843	11907	58359	67976	60855	41584	14260
t-value			4.303	2.365	12.71	2.04	12.706	12.706	12.71	4.303	2.26
1 STD all strata fished			2473	1933	3694	1183	3007	4100	3500	5466	2010
biomass											
201-300	729	186	2	0	31	0	858	78	15	108	0
	731	216	69	0	15	57	51	321	117	1588	0
	733	468	28	74	0	111	172	290	351	2071	0
	735	272	3823	352	2646	24	270	2557	1877	1486	0
301-400	730	170	0	0	0	0	0	0	0	0	0
	732	231	0	0	0	0	0	0	0	0	0
	734	228	0	0	0	0	0	0	0	50	0
	736	175	0	0	0	0	0	0	0	0	
401-500	737	227	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
	741	223	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
	745	348	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
	748	159	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**	**nf**
Total >200 fathoms			3922	426	2692	192	1351	3246	2360	5303	0
Total all strata fished			5874	7093	5740	13154	8728	7507	4788	8097	4094
upper			32789	18073	41373	18765	32059	41939	27442	16216	7427
t-value			4.303	2.571	12.71	2.16	12.706	12.706	12.71	3.182	2.36
1 STD all strata fished			6255	4271	2804	2598	1836	2710	1782	2552	1412

Table 32. Spring bottom-trawl mean number per tow at age in index strata (<=200 fath) in Division 3L adjusted for missing strata.

Age	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
0												0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00
1	0.00	0.00	0.24	0.05	0.00	0.16	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.05	0.23	0.69	0.28	0.76	0.16	0.19
2	24.66	4.71	6.20	4.56	6.56	8.14	4.82	1.29	0.08	0.19	0.25	0.43	0.18	0.08	0.54	0.87	0.86	0.89	0.27	1.10
3	85.66	17.70	11.95	24.30	23.92	46.84	13.81	2.26	1.71	0.33	0.19	0.23	0.43	0.25	0.26	0.86	0.35	0.43	0.38	0.31
4	48.28	31.74	11.45	10.16	20.06	41.76	19.67	1.82	0.79	0.12	0.16	0.15	0.16	0.25	0.17	0.69	0.13	0.16	0.12	0.19
5	23.76	18.51	19.07	9.93	5.23	18.34	9.80	2.54	0.34	0.06	0.05	0.05	0.07	0.11	0.11	0.08	0.11	0.07	0.07	0.07
6	8.24	9.85	13.15	17.32	3.62	5.05	4.25	1.09	0.24	0.01	0.01	0.05	0.03	0.07	0.08	0.08	0.01	0.02	0.02	0.01
7	7.17	3.96	6.27	7.39	8.32	4.30	1.07	0.36	0.07	0.00		0.03	0.20	0.02	0.08	0.01	0.00		0.00	0.02
8	1.39	2.95	1.95	3.71	6.06	4.74	0.85	0.06	0.04				0.06	0.02	0.05	0.00	0.01		0.00	0.01
9	0.65	0.65	1.52	1.25	1.58	2.53	0.80	0.01	0.00				0.02	0.01	0.16	0.00			0.00	0.00
10	0.92	0.56	0.58	1.04	0.62	1.02	0.28	0.04					0.01	0.00	0.06	0.00			0.00	0.00
11	1.04	0.96	0.41	0.30	0.54	0.44	0.28	0.00					0.01		0.03	0.01			0.00	0.00
12	0.35	0.62	0.54	0.36	0.14	0.28	0.09	0.00							0.01	0.01			0.00	0.01
13	0.14	0.21	0.33	0.32	0.19	0.21	0.03	0.01							0.01	0.01			0.03	0.00
14	0.04	0.07	0.10	0.25	0.33	0.15	0.01	0.01							0.01					0.01
15	0.06	0.06	0.05	0.10	0.13	0.13	0.02													0.00
16	0.01	0.02	0.01	0.04	0.04	0.07	0.00													0.01
17	0.00	0.00	0.00	0.03	0.03	0.05	0.00													
18	0.01	0.02	0.01	0.02	0.02	0.01	0.00													
19	0.00	0.00	0.01	0.00	0.01	0.01	0.01													
20	0.01	0.00		0.01			0.01													
21	0.01																			
22	0.00																			
23	0.01																			
24																				
25																				
TOTAL	202.41	92.59	73.84	81.14	77.40	134.23	55.80	9.49	3.27	0.71	0.66	1.00	1.17	0.86	1.80	3.33	1.75	2.33	1.05	1.93

Table 33. Estimated proportions mature for female cod from NAFO Divs. 2J3KL from DFO surveys from 1960 to 2004 projected forward to 2010. Estimates were obtained from a probit model fitted by cohort to observed proportions mature at age. Shaded cells are extrapolations of the first or last three estimates for the same age group or are the average of adjacent estimates for the same age group.

Year/Age	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1958	0.00000	0.00000	0.00004	0.00067	0.01123	0.15759	0.76340	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1959	0.00000	0.00000	0.00004	0.00067	0.01123	0.15759	0.76340	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1960	0.00000	0.00000	0.00000	0.00067	0.01123	0.15759	0.76340	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1961	0.00000	0.00000	0.00004	0.00002	0.01123	0.15759	0.76340	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1962	0.00004	0.00002	0.00008	0.00076	0.00092	0.15759	0.76340	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1963	0.00007	0.00022	0.00029	0.00123	0.01305	0.03961	0.76340	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1964	0.00020	0.00042	0.00146	0.00348	0.01973	0.18629	0.64934	0.98747	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1965	0.00034	0.00104	0.00262	0.00975	0.04024	0.24687	0.79859	0.98812	0.99940	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1966	0.00002	0.00166	0.00538	0.01602	0.06595	0.33472	0.84226	0.98565	0.99973	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1967	0.00000	0.00013	0.00814	0.02746	0.09165	0.35975	0.85790	0.98863	0.99916	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1968	0.00000	0.00002	0.00106	0.03891	0.12901	0.38477	0.82642	0.98638	0.99929	0.99995	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1969	0.00011	0.00000	0.00030	0.00856	0.16636	0.44034	0.79494	0.97321	0.99885	0.99996	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1970	0.00023	0.00062	0.00001	0.00374	0.06565	0.49592	0.81200	0.96005	0.99609	0.99990	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1971	0.00859	0.00125	0.00345	0.00029	0.04464	0.36374	0.82906	0.95995	0.99333	0.99941	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1972	0.01696	0.02169	0.00690	0.01871	0.00849	0.36775	0.82306	0.95986	0.99246	0.99892	0.99991	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1973	0.00000	0.04213	0.05387	0.03713	0.09244	0.20038	0.87865	0.97426	0.99159	0.99860	0.99983	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000
1974	0.00003	0.00002	0.10084	0.12975	0.17639	0.37182	0.88003	0.98903	0.99676	0.99828	0.99974	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000
1975	0.00017	0.00022	0.00030	0.22237	0.29903	0.54326	0.87427	0.99536	0.99911	0.99960	0.99965	0.99995	1.00000	1.00000	1.00000	1.00000	1.00000
1976	0.00013	0.00095	0.00181	0.00364	0.42167	0.59674	0.86852	0.98441	0.99984	0.99993	0.99995	0.99993	0.99999	1.00000	1.00000	1.00000	1.00000
1977	0.00005	0.00082	0.00525	0.01501	0.04298	0.65023	0.84715	0.97346	0.99748	0.99999	0.99999	0.99999	0.99999	1.00000	1.00000	1.00000	1.00000
1978	0.00000	0.00034	0.00508	0.02847	0.11360	0.35541	0.82579	0.94852	0.99512	0.99956	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1979	0.00000	0.00001	0.00244	0.03083	0.13997	0.51879	0.87129	0.92358	0.98184	0.99912	0.99992	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1980	0.00003	0.00002	0.00022	0.01733	0.16553	0.47476	0.90069	0.98811	0.96857	0.99327	0.99984	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000
1981	0.00019	0.00025	0.00028	0.00314	0.11293	0.55297	0.83389	0.98706	0.99902	0.98743	0.99744	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000
1982	0.00000	0.00096	0.00217	0.00420	0.04362	0.47885	0.88523	0.96537	0.99844	0.99992	0.99503	0.99901	0.99999	1.00000	1.00000	1.00000	1.00000
1983	0.00000	0.00003	0.00486	0.01860	0.05876	0.39791	0.86897	0.97963	0.99358	0.99981	0.99999	0.99805	0.99961	1.00000	1.00000	1.00000	1.00000
1984	0.00001	0.00001	0.00037	0.02413	0.14166	0.48053	0.90545	0.97954	0.99668	0.99884	0.99998	1.00000	0.99923	0.99985	1.00000	1.00000	1.00000
1985	0.00001	0.00014	0.00018	0.00452	0.11138	0.58970	0.93200	0.99284	0.99711	0.99947	0.99979	1.00000	1.00000	0.99970	1.00000	1.00000	1.00000
1986	0.00004	0.00012	0.00142	0.00274	0.05334	0.38847	0.92602	0.99510	0.99950	0.99960	0.99991	0.99996	1.00000	1.00000	1.00000	1.00000	1.00000
1987	0.00003	0.00030	0.00126	0.01388	0.03944	0.41140	0.76300	0.99091	0.99967	0.99997	0.99994	0.99999	0.99999	1.00000	1.00000	1.00000	1.00000
1988	0.00000	0.00022	0.00215	0.01266	0.12231	0.37997	0.89660	0.94225	0.99895	0.99998	1.00000	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000
1989	0.00000	0.00005	0.00195	0.01504	0.11515	0.57977	0.90144	0.99079	0.98805	0.99988	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1990	0.00000	0.00002	0.00100	0.01679	0.09763	0.56916	0.93178	0.99273	0.99925	0.99762	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1991	0.00011	0.00005	0.00046	0.01790	0.13020	0.43385	0.93061	0.99266	0.99951	0.99994	0.99953	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1992	0.00228	0.00097	0.00138	0.01309	0.24998	0.56745	0.84443	0.99271	0.99925	0.99997	1.00000	0.99991	1.00000	1.00000	1.00000	1.00000	1.00000
1993	0.00002	0.00822	0.00856	0.03654	0.27554	0.85909	0.91998	0.97465	0.99928	0.99992	1.00000	1.00000	0.99998	1.00000	1.00000	1.00000	1.00000
1994	0.00001	0.00024	0.02914	0.07112	0.51058	0.91603	0.99111	0.99017	0.99634	0.99993	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1995	0.00007	0.00013	0.00288	0.09803	0.40450	0.96633	0.99681	0.99951	0.99887	0.99948	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1996	0.00202	0.00075	0.00200	0.03356	0.28243	0.85767	0.99873	0.99989	0.99997	0.99987	0.99993	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1997	0.00058	0.00789	0.00784	0.02921	0.29435	0.58769	0.98164	0.99995	1.00000	1.00000	0.99999	0.99999	1.00000	1.00000	1.00000	1.00000	1.00000
1998	0.00003	0.00288	0.03027	0.07634	0.31123	0.83363	0.83771	0.99790	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
1999	0.00000	0.00030	0.01419	0.10911	0.46363	0.87156	0.98366	0.94922	0.99976	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
2000	0.00015	0.00000	0.00353	0.06689	0.32461	0.90040	0.99028	0.99862	0.98544	0.99997	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
2001	0.00007	0.00127	0.00008	0.03963	0.26303	0.65351	0.98953	0.99935	0.99988	0.99594	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
2002	0.00007	0.00081	0.01047	0.00783	0.32484	0.63988	0.88097	0.99899	0.99996	0.99999	0.99887	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
2003	0.00007	0.00069	0.00902	0.08082	0.42360	0.84869	0.89844	0.96672	0.99990	1.00000	1.00000	0.99969	1.00000	1.00000	1.00000	1.00000	1.00000
2004	0.00007	0.00069	0.00652	0.09299	0.42218	0.98561	0.98494	0.97780	0.99130	0.99999	1.00000	1.00000	0.99991	1.00000	1.00000	1.00000	1.00000
2005	0.00007	0.00069	0.00652	0.06054	0.53594	0.85859	0.99984	0.99869	0.99546	0.99777	1.00000	1.00000	1.00000	0.99998	1.00000	1.00000	1.00000
2006	0.00007	0.00069	0.00652	0.06054	0.46058	0.92862	0.98057	1.00000	0.99989	0.99908	0.99943	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000
2007	0.00007	0.00069	0.00652	0.06054	0.46058	0.92427	0.99322	0.99762	1.00000	0.99999	0.99982	0.99985	1.00000	1.00000	1.00000	1.00000	1.00000
2008	0.00007	0.00069	0.00652	0.06054	0.46058	0.92427	0.99121	0.99939	0.99971	1.00000	1.00000	0.99996	0.99996	1.00000	1.00000	1.00000	1.00000
2009	0.00007	0.00069	0.00652	0.06054	0.46058	0.92427	0.99121	0.99900	0.99995	0.99997	1.00000	1.00000	0.99999	0.99999	1.00000	1.00000	1.00000
2010	0.00007	0.00069	0.00652	0.06054	0.46058	0.92427	0.99121	0.99900	0.99989	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000	1.00000

Table 34. Mean length (cm) at age of cod sampled during autumn bottom-trawl surveys in divisions 2J, 3K and 3L in 1978-2004. Highlighted entries are based on fewer than 5 aged fish. There were no surveys in Div. 3L in 1978-1980 and 1984.

Division 2J

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1																		19.9	19.8		22.9	21.5	22.0	22.8	20.9	20.3	22.4
2	29.3	30.1	30.6	29.9	30.0	26.6	27.4	27.0	28.2	29.4	30.3	28.1	26.5	28.1	26.5	26.2	25.8	26.2	28.0	30.7	23.9	27.4	27.8	29.3	28.0	31.5	30.9
3	38.0	41.3	39.4	38.7	37.9	38.8	34.3	33.6	35.5	36.5	37.3	36.9	33.8	32.9	33.8	32.6	36.8	33.1	34.5	37.6	38.7	33.7	37.6	34.8	37.3	38.2	37.7
4	45.6	47.3	49.6	47.0	47.0	46.1	44.4	40.1	41.1	43.4	44.2	43.7	41.9	38.7	38.8	40.1	42.3	42.1	41.8	43.2	44.4	42.5	44.2	43.7	43.2	43.3	45.2
5	54.0	55.3	54.5	54.4	53.4	53.9	50.9	48.5	47.6	48.9	48.5	50.1	46.9	43.9	41.8	43.9	46.6	46.7	49.3	48.0	47.7	52.3	**54.6**	49.9	47.8	50.0	50.0
6	59.7	60.9	60.7	58.2	59.3	60.0	56.6	53.2	52.7	52.4	53.6	53.8	53.4	51.1	47.0	47.5	**56.8**	**55.4**	**52.6**		**52.5**	**69.0**	**62.3**	**54.0**	**41.0**	**60.1**	55.5
7	66.4	67.9	64.3	62.8	61.3	62.9	63.4	57.5	56.7	57.3	55.8	57.0	56.6	56.9	**56.8**	**47.0**	**56.2**		**61.1**		**51.0**			**57.0**			
8	69.7	73.9	69.5	66.9	64.5	64.7	65.8	64.3	59.5	58.9	59.8	59.6	59.4	58.3								**79.0**					
9	79.3	69.2	82.0	73.6	68.9	68.6	66.9	67.2	67.6	61.7	63.8	62.7	61.1	63.8													
10	80.4	76.9	83.3	84.2	77.0	73.5	71.6	70.2	68.2	67.8	66.2	64.7	63.1	65.5													
11	87.7	87.6	86.5	90.1	85.5	75.0	78.4	72.8	72.2	77.5	73.9	69.8	73.6	**72.7**													
12	91.6	85.9	87.9	88.6	94.6	95.0	83.0	75.9	76.2	75.5	80.5	67.8	73.5	**68.5**													

Division 3K

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1																		18.6	19.2	21.6	19.2	20.5	20.9	20.1	22.2	19.2	20.9
2	27.9	30.9	30.7	31.3	29.3	28.5	26.5	28.7	29.5	29.7	25.9	27.3	28.1	29.2	28.5	28.5	29.3	25.6	28.7	29.5	25.3	29.1	27.7	28.1	28.4	30.6	28.0
3	37.6	42.1	39.9	42.2	40.3	40.5	36.8	36.0	36.5	38.1	36.5	37.2	36.2	36.6	36.4	37.5	36.5	34.2	34.9	39.2	39.0	36.8	36.7	34.6	35.3	39.0	34.9
4	47.0	49.5	47.2	50.4	50.1	47.9	47.0	43.9	43.8	44.6	44.2	45.0	44.0	42.7	42.4	43.6	42.2	41.8	43.3	47.9	45.4	45.7	45.4	42.6	41.6	45.6	43.6
5	54.8	55.4	54.7	56.1	54.0	56.2	54.3	51.8	49.9	50.9	51.5	51.5	49.7	47.9	47.0	50.0	51.1	46.8	50.0	56.2	51.4	52.5	52.0	52.1	47.6	53.9	49.3
6	62.4	62.8	61.8	60.3	60.5	62.3	61.6	57.3	56.1	54.3	56.0	56.3	56.1	54.9	51.8	51.4	**53.5**	**54.7**	**58.5**		58.6	**55.7**	60.8	**54.9**	**56.5**		57.0
7	69.5	69.9	69.7	65.2	64.3	66.8	64.4	62.5	58.8	60.1	58.6	59.9	58.4	59.7	57.9	53.0	**58.1**		**69.0**		62.4	**72.9**	**73.0**		**57.0**		**59.9**
8	74.4	76.8	76.3	69.2	69.0	67.7	68.8	69.6	64.1	62.9	66.3	63.1	61.2	62.7	65.2	**64.0**	**61.7**			**68.0**	**83.0**			**74.0**			**81.0**
9	76.6	83.3	86.0	81.7	74.8	72.5	72.9	70.2	67.3	69.7	73.1	68.1	63.6	65.6	**64.0**			**68.0**			**80.0**	**81.0**		**73.0**			
10	81.9	78.3	87.6	90.5	79.8	76.4	78.1	73.1	76.8	74.5	78.7	74.0	64.7	69.1								**89.0**					**58.0**
11	**88.4**	86.0	**103.4**	91.6	89.6	84.9	84.9	79.2	75.9	80.8	82.4	75.7	69.3	**80.7**													
12	92.1	**78.9**	94.2	92.1	97.0	85.1	90.2	87.1	73.7	86.6	88.5	82.2	71.1	**68.4**													

Division 3L

Age	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1															16.8	17.7	19.7	18.4	19.3	19.3	18.4	20.6	17.7	20.1
2	28.5	28.7	30.1		26.8	27.9	27.5	28.7	28.7	27.0	29.7	27.9	30.1	28.1	27.8	30.0	30.3	31.5	30.0	28.3	28.8	29.4	29.0	28.9
3	40.0	38.2	39.4		36.1	35.4	34.7	37.4	37.6	35.3	36.7	38.5	38.3	34.8	36.9	38.3	38.6	39.9	39.4	39.4	36.7	38.7	39.7	37.3
4	44.8	50.2	48.0		43.7	43.7	44.2	44.9	44.2	44.9	44.4	44.5	45.2	45.7	41.7	44.2	45.9	46.5	47.2	45.8	44.8	47.1	50.0	47.8
5	52.6	56.4	56.8		52.2	50.3	52.3	53.1	52.3	52.7	51.1	50.4	51.5	51.8	49.6	49.3	54.9	**54.5**	55.4	53.3	51.3	56.2	51.0	50.1
6	60.6	63.5	62.4		58.0	58.2	58.9	58.6	59.0	59.2	56.5	54.9	55.8	57.9	58.6	58.9	**62.3**	**58.4**	59.7	58.0	57.9	62.7	**60.5**	**58.9**
7	66.7	69.7	64.7		65.4	62.6	65.1	62.4	63.9	66.4	61.1	56.8	61.9	**66.7**	**66.7**	66.7	68.6	**78.0**	**64.0**	**65.4**	**65.9**	**68.0**	**71.0**	**72.0**
8	73.1	73.8	69.5		73.3	69.9	69.0	66.7	68.7	70.9	68.0	66.0	**61.4**	**67.0**	**74.0**	**70.0**	72.6	**74.3**	72.9	**77.9**	**67.9**			**57.0**
9	82.2	83.0	73.6		72.8	73.1	75.2	69.6	74.4	75.3	71.5	77.3				**66.0**	**72.0**		**86.3**	**81.0**	**75.1**		**70.0**	**69.0**
10	91.2	93.1	76.3		82.6	77.7	80.8	74.3	83.7	76.2	73.2	70.4	**87.0**						**90.7**					**82.0**
11	**103.7**	94.1	90.0		86.5	81.5	87.9	88.9	88.1	82.5	74.5	**77.1**							**79.0**		**91.0**		**89.0**	
12	**119.2**	110.5	87.5		97.8	86.8	85.4	96.7	94.1	86.9	81.1	**94.5**							**100.0**		**101.0**	**98.0**		

Table 35. Mean weight (kg) at age of cod sampled during autumn bottom-trawl surveys in divisions 2J, 3K and 3L in 1978-2004. Highlighted entries are based on fewer than 5 aged fish. There were no surveys in Div. 3L in 1978-1980 and 1984.

Division 2J

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1																		0.06	0.06		0.10	0.09	0.09	0.10	0.09
2	0.22	0.26	0.24	0.23	0.22	0.18	0.15	0.20	0.25	0.27	0.25	0.20	0.16	0.19	0.14	0.15	0.16	0.16	0.19	0.26	0.12	0.20	0.19	0.23	0.20
3	0.49	0.68	0.53	0.55	0.50	0.59	0.38	0.36	0.35	0.55	0.55	0.49	0.36	0.31	0.32	0.30	0.43	0.32	0.37	0.48	0.54	0.36	0.47	0.38	0.47
4	0.95	1.02	1.05	1.08	0.96	0.96	0.83	0.62	0.65	0.91	0.82	0.81	0.70	0.52	0.48	0.58	0.65	0.67	0.67	0.73	0.80	0.76	0.78	0.73	0.73
5	1.58	1.59	1.36	**1.66**	1.60	1.55	1.30	1.14	1.05	1.36	1.15	1.26	0.99	0.74	0.62	0.75	0.91	0.90	1.16	1.05	1.01	1.38	**1.42**	1.17	1.03
6	2.20	2.38	2.06	1.98	2.00	1.85	1.78	1.49	1.66	1.48	1.65	1.57	1.46	1.14	0.84	0.92	**1.66**	**1.54**	**1.43**		**1.42**	**3.21**	**2.46**	**1.34**	**0.58**
7	2.52	2.75	2.55	2.52	2.39	**2.25**	2.39	1.88	1.91	2.07	1.69	1.91	1.78	1.54	**1.48**	**0.86**	**1.70**		**2.15**		**1.19**			**1.64**	
8	3.86	2.75	**3.09**	3.20	2.69	2.77	2.56	2.50	2.29	2.41	2.38	2.26	2.11	1.69								**5.18**			
9	4.37	6.19	5.99	3.94	3.87	3.35	3.02	2.65	**3.81**	1.82	2.72	2.62	2.30	2.37											
10	5.77	**5.43**	7.63	6.59	6.51	4.02	3.46	3.22	4.51	4.65	2.88	3.14	2.54	2.72											
11	6.36	7.19	6.55	**6.91**	**7.66**	4.17	5.67	4.18	4.64	**4.55**	3.87	3.77	4.40	**3.96**											
12	**9.74**	**6.21**	7.72	**10.80**	**10.06**	8.95	6.54	4.01	6.16	**4.65**	6.73	3.21	4.34	**3.39**											

Division 3K

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1																		0.05	0.06	0.09	0.06	0.07	0.08	0.07	0.09
2	0.17	0.21	0.24	0.28	0.23	0.23	0.15	0.21	0.19	0.20	0.18	0.19	0.19	0.21	0.21	0.21	0.22	0.15	0.21	0.23	0.15	0.24	0.19	0.20	0.21
3	0.41	0.58	0.58	0.72	0.74	0.54	0.40	0.47	0.45	0.49	0.48	0.49	0.41	0.42	0.40	0.47	0.43	0.36	0.38	0.54	0.55	0.47	0.44	0.36	0.40
4	0.88	1.19	0.95	1.22	1.22	1.12	0.87	0.89	0.82	0.90	0.84	0.87	0.76	0.71	0.67	0.74	0.69	0.65	0.72	0.98	0.87	0.89	0.82	0.71	0.65
5	1.48	1.64	1.41	**1.73**	1.56	1.67	1.41	1.22	1.15	1.35	1.41	1.33	1.10	1.01	0.95	1.12	1.19	0.91	1.16	1.62	1.30	1.35	1.19	1.26	1.00
6	2.39	2.26	2.01	2.05	1.97	2.11	2.04	1.82	1.99	1.41	1.73	1.82	1.63	1.52	1.30	1.30	**1.44**	**1.53**	**1.90**		1.87	**1.56**	2.06	**1.50**	**1.52**
7	2.94	3.16	3.46	2.62	2.45	2.80	2.34	2.59	2.42	2.58	2.26	2.19	1.91	1.92	1.83	1.46	**1.98**		**3.24**		2.55	**3.74**	**3.33**		**1.71**
8	**5.83**	4.28	3.18	5.05	3.15	3.44		3.40	3.74	2.78	3.01	2.57	2.20	2.27	2.56	**2.29**	**2.33**			**2.61**	**6.32**			**3.45**	
9	4.67	4.86	6.00	7.33	4.38	3.74	3.69	4.15	3.25	3.40	4.26	3.23	2.44	2.63	**2.19**			**3.28**			**5.31**	**6.13**		**3.71**	
10	6.50	4.61	7.53	6.32	6.19	4.86	4.67	4.89	4.92	5.35	4.89	4.20	2.71	3.11								**7.27**			
11	**5.24**	8.37	**13.00**	9.33	6.52	7.51	6.30	6.52	5.85	**10.63**	5.41	4.60	3.25	**4.93**											
12	**9.49**	**10.19**	7.10	8.10	**9.56**	**6.05**	6.09	6.33	**6.47**	7.02	7.63	5.59	3.67	**3.22**											

Division 3L

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
1																		0.11	0.05	0.07	0.05	0.06	0.06	0.05	0.08
2				**0.22**	0.17	0.24		0.17	0.22	0.18	0.22	0.19	0.17	0.25	0.20	0.24	0.20	0.24	0.26	0.26	0.27	0.26	0.21	0.23	0.24
3				0.56	0.38	0.54		0.44	0.47	0.35	0.46	0.44	0.40	0.46	0.58	0.51	0.40	0.46	0.50	0.53	0.59	0.58	0.58	0.47	0.55
4				0.82	**0.48**	1.14		0.80	0.80	0.74	0.76	0.79	0.81	0.84	0.88	0.85	0.88	0.67	0.78	0.90	0.94	0.94	0.89	0.85	0.97
5				1.25		1.48		1.38	1.23	1.31	1.37	1.56	1.33	1.28	1.30	1.27	1.32	1.13	1.12	1.63	**1.59**	1.62	1.43	1.34	1.75
6				1.98		1.98		2.05	1.81	1.80	1.88	1.94	1.90	1.75	1.70	1.76	1.89	2.06	2.08	**2.63**	**1.81**	2.07	1.85	1.91	2.33
7				2.64		2.28		2.25	2.70	2.35	2.10	2.57	2.77	2.19	1.86	2.33	**2.99**	**3.25**	3.23	3.39	**4.25**	**2.62**	**2.76**	2.87	**3.02**
8				5.08	**5.44**	2.93		3.52	2.58	2.82	3.04	3.65	3.48	3.09	2.78	**2.55**	**3.16**	**4.20**	**3.44**	4.47	**4.60**	**3.90**	**5.16**	**3.23**	
9				5.80	6.65	4.01		4.11	4.20	3.80	3.02	3.67	4.27	3.68	4.93				**3.20**			**6.63**	**4.85**	**3.72**	
10				11.76	8.34	4.39		6.13	5.48	**7.54**	3.48	6.83	4.56	3.95	3.35	**6.44**						**8.28**			
11				**11.56**	7.49	8.33		5.31	4.46	7.40	7.47	7.46	5.85	4.47	**4.95**							**5.63**		8.26	
12				**18.55**	**10.65**	**9.90**		12.08	10.51	5.53	9.41	**11.40**	6.64	5.31	**8.65**							**10.05**		**12.80**	**9.95**

Table 36. Mean Fulton's condition (gutted weight) at age of cod sampled during autumn bottom-trawl surveys in divisions 2J, 3K and 3L in 1978-2004. Highlighted entries are based on fewer than 5 aged fish. There were no surveys in Div. 3L in 1978-1980 and 1984.

Division 2J

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.733	0.718	0.738	0.781	0.735	0.731	0.713	0.722	0.718	0.730	0.753	0.745	0.714	0.710	0.666	0.741	0.803	0.740	0.733	0.743	0.733	0.729	0.721	0.728	0.742	0.725	0.768
3	0.729	0.755	0.788	0.811	0.775	0.772	0.758	0.741	0.779	0.813	0.786	0.764	0.741	0.736	0.710	0.758	0.755	0.743	0.755	0.758	0.776	0.754	0.734	0.759	0.751	0.741	0.772
4	0.762	0.763	0.718	0.810	0.757	0.803	0.774	0.755	0.814	0.792	0.816	0.772	0.745	0.735	0.693	0.759	0.745	0.758	0.791	0.755	0.750	0.751	0.755	0.738	0.741	0.740	0.768
5	0.771	0.750	0.764	**0.816**	0.816	0.774	0.784	0.769	0.816	0.770	0.786	0.786	0.744	0.724	0.709	0.752	0.773	0.736	0.809	0.787	0.754	0.776	**0.736**	0.797	0.747	0.787	0.799
6	0.747	0.785	0.750	0.821	0.801	0.729	0.767	0.757	0.815	0.783	0.812	0.789	0.753	0.702	0.678	0.717	**0.771**	**0.735**	**0.769**		**0.770**	**0.816**	**0.822**	**0.737**	**0.711**	**0.777**	0.849
7	0.731	0.762	0.738	0.795	0.757	**0.661**	0.776	0.751	0.814	0.783	0.798	0.782	0.743	0.707	**0.687**	**0.722**	**0.779**		**0.824**		**0.686**			**0.745**			
8	0.722	0.695	**0.743**	0.809	0.737	0.789	0.732	0.761	0.776	0.836	0.815	0.806	0.762	0.705								**0.842**					
9	0.764	0.823	0.806	0.749	0.729	0.789	0.751	0.669	**0.849**	0.768	0.811	0.793	0.771	0.738													
10	0.779	**0.794**	0.814	0.859	0.814	0.758	0.755	0.724	0.794	0.772	0.813	0.874	0.748	0.783													
11	0.834	0.831	0.760	**0.855**	**0.855**	0.801	0.786	0.730	0.870	**0.792**	0.798	0.806	0.817	**0.835**													
12	**0.904**	**0.766**	0.838	**0.845**	**0.858**	0.786	0.799	0.725	0.828	**0.795**	0.827	0.766	0.828	**0.830**													

Division 3K

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.683	0.707	0.708	0.793	0.722	0.725	0.685	0.730	0.749	0.768	0.753	0.716	0.711	0.733	0.735	0.727	0.741	0.733	0.739	0.744	0.723	0.735	0.735	0.732	0.737	0.725	0.747
3	0.719	0.741	0.786	0.793	0.815	0.742	0.719	0.744	0.714	0.757	0.785	0.750	0.714	0.719	0.700	0.741	0.767	0.744	0.746	0.758	0.758	0.761	0.738	0.728	0.746	0.736	0.771
4	0.747	0.757	0.805	0.769	0.758	0.781	0.733	0.731	0.774	0.772	0.796	0.755	0.724	0.736	0.711	0.720	0.768	0.730	0.753	0.747	0.761	0.759	0.740	0.748	0.751	0.739	0.762
5	0.747	0.780	0.747	**0.826**	0.754	0.768	0.753	0.765	0.783	0.785	0.799	0.763	0.734	0.733	0.718	0.717	0.730	0.737	0.782	0.766	0.780	0.761	0.711	0.720	0.757	0.744	0.799
6	0.739	0.747	0.726	0.789	0.738	0.728	0.744	0.784	0.798	0.778	0.808	0.781	0.744	0.742	0.739	0.746	**0.765**	**0.766**	**0.745**		0.746	**0.740**	0.748	**0.747**	**0.721**		0.777
7	0.730	0.739	0.729	0.749	0.731	0.799	0.784	0.746	0.820	0.819	0.808	0.768	0.749	0.730	0.754	0.721	**0.780**		**0.801**		0.864	**0.784**	**0.743**		**0.826**		**0.731**
8	**0.773**	0.746	0.687	0.751	0.732	0.809		0.764	0.795	0.788	0.833	0.779	0.749	0.738	0.736	**0.732**	**0.799**			**0.706**	**0.867**			**0.748**			**0.726**
9	0.784	0.738	0.758	0.847	0.721	0.760	0.781	0.841	0.821	0.796	0.819	0.791	0.732	0.755	**0.679**			**0.795**			**0.873**	**0.896**		**0.745**			
10	0.744	0.761	0.795	0.756	0.766	0.762	0.717	0.744	0.849	0.811	0.831	0.793	0.749	0.776								**0.817**					**0.841**
11	**0.642**	0.752	**0.861**	0.836	0.749	0.838	0.822	0.778	0.840	**0.832**	0.788	0.808	0.771	**0.741**													
12	**0.845**	**0.812**	0.762	0.815	**0.813**	**0.755**	0.789	0.835	**0.785**	0.810	0.852	0.792	0.778	**0.803**													

Division 3L

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2				**0.718**	0.707	0.718		0.680	0.769	0.721	0.748	0.734	0.716	0.746	0.744	0.721	0.750	0.935	0.772	0.757	0.744	0.740	0.715	0.740	0.749	0.737	0.763
3				0.778	0.803	0.724		0.749	0.765	0.733	0.781	0.759	0.734	0.748	0.801	0.741	0.784	0.752	0.749	0.758	0.751	0.798	0.757	0.760	0.762	0.756	0.786
4				0.794	**0.765**	0.746		0.740	0.757	0.745	0.730	0.764	0.729	0.769	0.788	0.737	0.741	0.758	0.770	0.756	0.748	0.749	0.762	0.755	0.757	0.735	0.754
5				0.767		0.735		0.756	0.790	0.748	0.781	0.782	0.752	0.769	0.795	0.715	0.758	0.761	0.760	0.773	**0.814**	0.776	0.750	0.767	0.785	0.736	0.725
6				0.729		0.700		0.717	0.781	0.714	0.796	0.776	0.742	0.773	0.796	0.777	0.776	0.804	0.806	**0.770**	**0.751**	0.788	0.754	0.783	0.739	**0.762**	**0.871**
7				0.751		0.775		0.715	0.816	0.724	0.741	0.768	0.763	0.741	0.793	0.737	**0.775**	**0.861**	0.847	0.824	**0.748**	**0.790**	**0.771**	**0.768**	**0.776**	**0.766**	**0.723**
8				0.824	**0.767**	0.764		0.708	0.730	0.735	0.758	0.804	0.777	0.763	0.723	**0.741**	**0.725**	**0.780**	**0.825**	0.882	**0.861**	**0.822**	**0.806**	**0.767**			**0.740**
9				0.798	0.800	0.744		0.790	0.775	0.743	0.781	0.729	0.773	0.779	0.803				**0.939**			**0.809**	**0.743**	**0.734**		**0.700**	**0.834**
10				**0.888**	0.827	0.749		0.783	0.808	**0.852**	0.746	0.798	0.785	0.758	0.743	**0.787**						**0.890**					**0.851**
11				**0.800**	0.807	0.793		0.774	0.775	0.803	0.736	0.802	0.795	0.817	**0.814**							**0.909**		0.809		**0.901**	
12				**0.885**	**0.771**	**0.752**		0.817	0.811	0.783	0.828	**0.822**	0.792	0.771	**0.808**							**0.750**		**0.956**	**0.813**		

Table 37. Mean liver index at age of cod sampled during autumn bottom-trawl surveys in divisions 2J, 3K and 3L in 1978-2004. Highlighted entries are based on fewer than 5 aged fish. (Instances where fewer than 5 aged fish were available are not indicated for years prior to 1995.) There were no surveys in Div. 3L in 1978-1980 and 1984.

Division 2J

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2		0.037	0.035	0.046	0.031	0.030	0.032	0.023	0.043	0.031	0.036	0.045	0.042	0.036	0.025	0.032	0.038	0.042	0.037	0.041	0.034	0.045	0.035	0.041	0.044	0.039	0.051
3		0.061	0.051	0.049	0.047	0.057	0.050	0.036	0.049	0.052	0.049	0.059	0.050	0.042	0.028	0.038	0.039	0.041	0.044	0.043	0.050	0.049	0.038	0.047	0.042	0.038	0.050
4		0.062	0.034	0.069	0.048	0.078	0.061	0.048	0.079	0.061	0.067	0.067	0.060	0.045	0.040	0.037	0.035	0.041	0.039	0.045	0.047	0.046	0.036	0.041	0.043	0.038	0.052
5		0.064	0.052	0.053	0.051	0.063	0.066	0.057	0.077	0.073	0.057	0.076	0.061	0.037	0.036	0.038	0.043	0.045	0.043	0.053	0.052	0.054	**0.035**	0.037	0.037	0.040	0.047
6		0.080	0.054	0.062	0.060	0.065	0.062	0.056	0.089	0.065	0.074	0.074	0.064	0.033	0.037	0.038	0.049	**0.017**	**0.037**		**0.065**	**0.069**	**0.042**	**0.023**	**0.044**	**0.049**	0.069
7		0.060	0.055	0.056	0.057	0.057	0.055	0.053	0.074	0.061	0.070	0.077	0.067	0.031	0.036	0.030	0.073		**0.047**		**0.057**			**0.036**			
8		0.040	0.041	0.067	0.051	0.077	0.055	0.061	0.051	0.077	0.076	0.089	0.066	0.033								**0.090**					
9		0.060	0.071	0.058	0.048	0.081	0.066	0.034	0.093	0.045	0.065	0.074	0.073	0.038													
10		0.083	0.084	0.083	0.058	0.053	0.063	0.052	0.071	0.060	0.072	0.097	0.058	0.034													
11		0.097	0.074	0.058	0.052	0.062	0.065	0.065	0.092	0.075	0.068	0.083	0.065	0.042													
12		0.076	0.083	0.061	0.099	0.050	0.053	0.052	0.098	0.089	0.082	0.073	0.084	0.043													

Division 3K

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2	0.030	0.019	0.021	0.040	0.020	0.024	0.013	0.035	0.029	0.029	0.025	0.032	0.035	0.037	0.035	0.042	0.034	0.045	0.039	0.040	0.037	0.046	0.036	0.042	0.048	0.038	0.047
3	0.020	0.033	0.038	0.044	0.033	0.039	0.032	0.053	0.049	0.046	0.044	0.047	0.042	0.044	0.037	0.043	0.044	0.046	0.044	0.045	0.043	0.052	0.042	0.041	0.048	0.039	0.052
4	0.032	0.054	0.047	0.041	0.045	0.052	0.037	0.053	0.061	0.049	0.056	0.056	0.052	0.052	0.048	0.045	0.049	0.047	0.044	0.045	0.050	0.054	0.042	0.044	0.045	0.041	0.054
5	0.040	0.066	0.046	0.035	0.061	0.047	0.046	0.054	0.069	0.056	0.069	0.057	0.051	0.054	0.055	0.051	0.053	0.050	0.046	0.049	0.055	0.052	0.037	0.039	0.048	0.044	0.055
6	0.037	0.062	0.052	0.054	0.044	0.035	0.041	0.054	0.082	0.064	0.070	0.071	0.055	0.052	0.059	0.058	0.054	**0.048**	**0.038**		0.061	**0.055**	0.041	**0.053**	**0.042**		**0.045**
7	0.040	0.061	0.045	0.043	0.049	0.035	0.047	0.044	0.082	0.078	0.061	0.071	0.057	0.043	0.064	0.050	0.065		**0.059**		0.070	**0.056**	**0.040**		**0.044**		
8	0.057	0.058	0.049	0.049	0.052	0.066		0.055	0.074	0.051	0.078	0.072	0.066	0.046	0.059	0.032	0.071			**0.032**	**0.138**			**0.037**			**0.068**
9	0.059	0.055	0.045	0.070	0.042	0.046	0.047	0.075	0.064	0.053	0.059	0.072	0.060	0.052	0.061			**0.036**			**0.073**	**0.113**		**0.030**			
10	0.062	0.061	0.047	0.059	0.057	0.049	0.037	0.049	0.081	0.070	0.069	0.071	0.064	0.054								**0.096**					**0.097**
11	0.033	0.066	0.051	0.077	0.055	0.063	0.065	0.066	0.080	0.091	0.073	0.075	0.062	0.038													
12	0.071	0.080	0.066	0.066	0.062	0.024	0.046	0.052	0.097	0.073	0.070	0.071	0.079	0.034													

Division 3L

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
2				0.021	0.013	0.025		0.029	0.030	0.026	0.025	0.026	0.039	0.046	0.041	0.043	0.039	0.039	0.039	0.042	0.040	0.046	0.039	0.043	0.050	0.042	0.048
3				0.041	0.025	0.022		0.031	0.032	0.032	0.028	0.036	0.038	0.056	0.067	0.053	0.078	0.048	0.040	0.047	0.045	0.056	0.043	0.047	0.048	0.043	0.055
4				0.038	0.042	0.024		0.039	0.035	0.031	0.035	0.039	0.037	0.062	0.073	0.062	0.053	0.049	0.044	0.049	0.051	0.050	0.048	0.050	0.051	0.038	0.045
5				0.039		0.027		0.039	0.047	0.035	0.043	0.052	0.042	0.059	0.076	0.066	0.052	0.050	0.044	0.055	**0.067**	0.055	0.047	0.052	0.062	0.053	0.048
6				0.039		0.030		0.033	0.040	0.030	0.045	0.045	0.048	0.060	0.071	0.075	0.074	0.066	0.064	**0.053**	**0.062**	0.047	0.052	0.051	0.051	**0.047**	**0.081**
7				0.041		0.041		0.030	0.045	0.029	0.051	0.053	0.057	0.059	0.073	0.066	0.044	**0.080**	0.078	0.069	**0.042**	**0.091**	**0.066**	**0.056**	**0.038**	**0.042**	**0.052**
8				0.065	0.039	0.032		0.046	0.033	0.032	0.043	0.058	0.055	0.069	0.065	0.033	0.035	**0.053**	**0.102**	0.068	0.079	**0.066**	**0.086**	**0.065**			**0.059**
9				0.049	0.061	0.039		0.051	0.056	0.036	0.050	0.051	0.059	0.075	0.070				**0.137**	**0.087**	**0.080**	**0.076**	**0.051**	**0.041**		**0.028**	**0.085**
10				0.077	0.054	0.041		0.066	0.052	0.091	0.039	0.059	0.057	0.066	0.074	0.098						**0.084**					**0.066**
11				0.052	0.068	0.042		0.060	0.048	0.059	0.044	0.067	0.069	0.074	0.090						**0.082**	**0.081**		0.067		**0.096**	
12				0.068	0.066	0.045		0.071	0.060	0.050	0.070	0.055	0.065	0.056	0.068							**0.060**		**0.146**	**0.092**		

Table 38. Central inshore SPA. Catch numbers at age (thousands). The 10+ group is the sum of ages 10-20.

C@A	2	3	4	5	6	7	8	9	10+
1995	0.03	5.73	29.88	72.78	51.24	19.55	5.50	0.90	0.39
1996	0.43	15.07	85.68	233.86	323.85	75.09	11.87	2.18	0.82
1997	0.02	7.29	24.98	57.25	70.89	110.48	19.19	2.26	0.77
1998	2.08	77.77	174.35	316.19	546.07	320.19	190.29	51.74	14.92
1999	5.63	60.32	191.65	508.01	609.21	912.76	306.12	222.13	51.08
2000	3.89	87.34	168.98	270.52	297.39	244.20	219.58	114.07	141.39
2001	7.91	162.85	500.44	507.82	436.73	266.27	135.33	208.60	208.99
2002	4.86	126.73	174.43	239.12	218.55	179.80	99.83	69.67	215.31
2003	0.13	7.93	9.04	16.47	45.82	39.89	25.69	21.34	97.45
2004	0.87	9.04	17.78	22.62	30.34	33.71	21.76	9.94	15.49

Table 39. Central inshore SPA. Sentinel survey catch rate at age from three gears.

Sent_GN_5.5	3	4	5	6	7	8	9
1995.5	0.000	0.041	1.546	2.153	0.997	0.443	0.074
1996.5	0.047	0.234	1.740	7.743	2.244	0.522	0.106
1997.5	0.018	0.124	1.930	3.658	6.590	1.452	0.149
1998.5	0.074	0.214	2.061	7.319	5.469	3.036	0.809
1999.5	0.027	0.153	1.393	2.355	3.681	1.145	0.637
2000.5	0.024	0.105	1.098	2.058	1.383	1.607	0.601
2001.5	0.017	0.097	0.508	1.255	0.758	0.344	0.477
2002.5	0.014	0.057	0.758	0.994	0.780	0.334	0.205
2003.5	0.057	0.132	0.475	1.598	1.056	0.388	0.190
2004.5	0.023	0.184	1.089	1.740	1.481	0.507	0.195

Sent GN_3.25	3	4	5	6	7	8	9
1996.5	10.184	21.767	8.693	9.129	0.367	0.046	0.000
1997.5	6.335	12.962	5.351	5.124	4.132	0.463	0.019
1998.5	7.993	4.387	4.889	8.715	4.685	1.924	0.459
1999.5	9.591	6.415	4.613	1.882	1.969	0.365	0.222
2000.5	9.608	7.766	3.553	1.831	0.528	0.476	0.189
2001.5	9.187	8.108	2.798	1.365	0.320	0.091	0.131
2002.5	12.759	6.158	1.940	1.040	0.345	0.048	0.032
2003.5	21.921	9.749	2.883	1.395	0.563	0.093	0.029
2004.5	8.916	10.022	5.234	1.833	0.563	0.108	0.041

Sent_LT	3	4	5	6	7
1995.5	8	62	56	19	5
1996.5	21	38	51	29	5
1997.5	21	48	76	44	41
1998.5	19	34	25	15	6
1999.5	11	21	27	6	1
2000.5	6	9	8	5	1
2001.5	23	30	12	3	1
2002.5	14	23	14	7	1
2003.5	27	68	33	5	1
2004.5	35	53	25	23	1

Table 40. Central inshore SPA. Parameter estimates and associated standard error for the ADAPT model fit for inshore catch and survey indices.

Parameter	Estimate	Standard Error	Bias	Rel Error	Rel Bias
N[2005 4]	5624.82	1776.90	310.94	0.32	0.06
N[2005 5]	5541.387	1259.63	172.25	0.23	0.03
N[2005 6]	2337.038	443.84	54.08	0.19	0.02
N[2005 7]	1113.029	192.77	22.08	0.17	0.02
N[2005 8]	461.2986	84.64	9.56	0.18	0.02
N[2005 9]	209.3849	44.33	5.20	0.21	0.02
N[2005 10]	250.7877	69.52	9.24	0.28	0.04
Sent 5.5 GN_3	4.93E-06	9.11E-07	5.73E-08	0.18	0.01
Sent 5.5 GN_4	2.76E-05	4.72134E-06	2.62E-07	0.17	0.01
Sent 5.5 GN_5	0.000401	6.83601E-05	3.76E-06	0.17	0.01
Sent 5.5 GN_6	0.001507	0.000259426	1.44E-05	0.17	0.01
Sent 5.5 GN_7	0.002208	0.000390968	2.27E-05	0.18	0.01
Sent 5.5 GN_8	0.001777	0.000327538	2.04E-05	0.18	0.01
Sent 5.5 GN_9	0.001185	0.000229062	1.56E-05	0.19	0.01
Sent LT_3	0.002576	0.000450144	2.57E-05	0.17	0.01
Sent LT_4	0.007808	0.001335907	7.42E-05	0.17	0.01
Sent LT_5	0.009398	0.00160158	8.82E-05	0.17	0.01
Sent LT_6	0.006804	0.001171008	6.5E-05	0.17	0.01
Sent LT_7	0.002918	0.000516535	3E-05	0.18	0.01
Sent 3.25 GN_3	0.001741	0.000321904	2.02E-05	0.18	0.01
Sent 3.25 GN_4	0.002141	0.000386648	2.37E-05	0.18	0.01
Sent 3.25 GN_5	0.001613	0.000289342	1.76E-05	0.18	0.01
Sent 3.25 GN_6	0.001605	0.000290671	1.78E-05	0.18	0.01
Sent 3.25 GN_7	0.00097	0.000180722	1.16E-05	0.19	0.01
Sent 3.25 GN_8	0.000418	8.10712E-05	5.56E-06	0.19	0.01
Sent 3.25 GN_9	0.000317	6.87077E-05	5.69E-06	0.22	0.02

Table 41. Central inshore SPA. Estimated abundance at age (bias corrected) in thousands. Shaded values indicate cohorts without index data; geometric means are used to fill these cohorts.

Pop #s Bias A	2	3	4	5	6	7	8	9	10
1995	11745	17133	8217	8919	2119	504	206	150	0
1996	9906	7873	11480	5484	5919	1379	322	133	99
1997	8838	6640	5265	7625	3486	3705	863	206	154
1998	7904	5925	4445	3509	5065	2279	2394	563	239
1999	8024	5296	3908	2838	2096	2953	1269	1451	483
2000	9074	5374	3501	2464	1493	917	1248	605	1076
2001	11664	6079	3531	2210	1432	761	419	659	920
2002	17895	7812	3943	1963	1073	610	298	173	723
2003	11843	11992	5133	2502	1122	543	264	120	372
2004	12582	7938	8032	3434	1664	715	331	156	234
2005	12586	8433	5314	5369	2283	1091	452	204	242

Table 42. Central inshore SPA. Estimated fishing mortality at age (bias corrected).

F Bias Adj(ana	2	3	4	5	6	7	8	9	10	Fbar(5-10)
1995	0.000	0.000	0.004	0.010	0.030	0.049	0.036	0.008	0.005	0.023
1996	0.000	0.002	0.009	0.053	0.069	0.068	0.046	0.018	0.012	0.044
1997	0.000	0.001	0.006	0.009	0.025	0.037	0.027	0.012	0.008	0.020
1998	0.000	0.016	0.049	0.115	0.139	0.186	0.101	0.118	0.079	0.123
1999	0.001	0.014	0.061	0.243	0.427	0.461	0.342	0.204	0.136	0.302
2000	0.001	0.020	0.060	0.143	0.273	0.384	0.238	0.257	0.172	0.245
2001	0.001	0.033	0.187	0.323	0.454	0.539	0.486	0.476	0.318	0.433
2002	0.000	0.020	0.055	0.159	0.282	0.435	0.512	0.657	0.440	0.414
2003	0.000	0.001	0.002	0.008	0.051	0.093	0.126	0.237	0.375	0.149
2004	0.000	0.001	0.003	0.008	0.022	0.059	0.084	0.081	0.081	0.056

Table 43. Input parameters for deterministic projection.

Catch Options

0t, 2500t, 5000t

Recruitment at age 2 (in thousands; see text)

Low	7166
Medium	12586
High	17155

Natural Mortality

M	0.4

Projection PR at age

Age	2	3	4	5	6	7	8	9	10
	0.001	0.043	0.178	0.397	0.712	1.000	0.793	0.902	0.644

Stock Weights at age

	2	3	4	5	6	7	8	9	10
	0.321	0.465	0.711	1.153	1.757	2.413	2.972	3.582	4.191

Catch Weights at age

	2	3	4	5	6	7	8	9	10
	0.362	0.560	0.868	1.524	2.143	2.784	3.318	3.943	4.591

Table 44a. Deterministic projections. Percent change from 2005 to 2006 in spawner biomass relative to the 2005 estimate (12,800 t) under three recruitment options (see text), and three fixed catch options.

% Change in SSB between 2005-2006 (Jan.1)				
Recruitment		Catch Option		
		0t	2,500t	5,000t
	Low	26%	9%	-7%
	Medium	27%	10%	-6%
	High	27%	11%	-5%

Table 44b. Deterministic projections. Percent change from 2005 to 2008 in spawner biomass relative to the 2005 estimate (12,800 t) under three recruitment options (see text), and three fixed catch options.

% Change in SSB between 2005-2008 (Jan.1)				
Recruitment		Catch Option		
		0t	2,500t	5,000t
	Low	35%	-8%	-50%
	Medium	57%	14%	-28%
	High	75%	32%	-10%

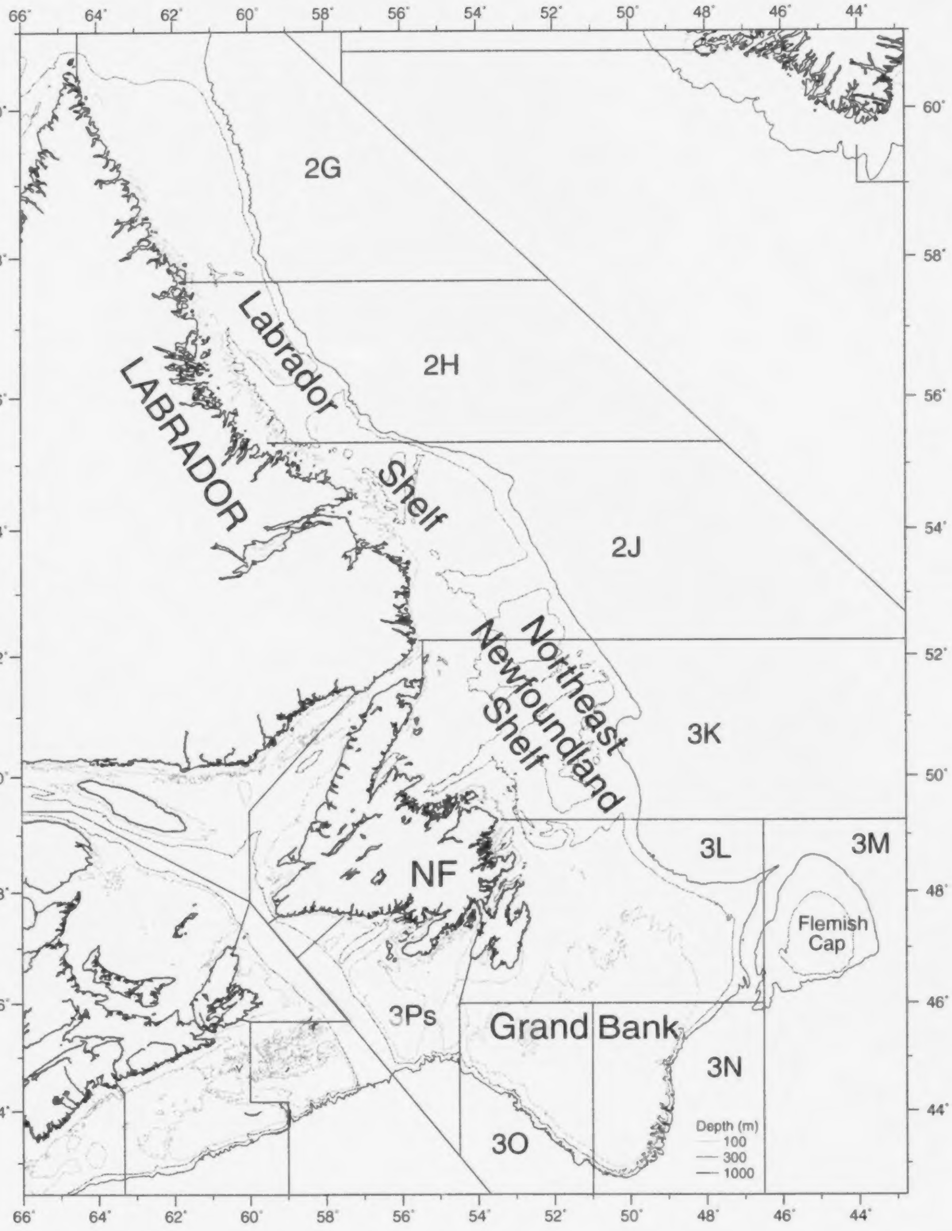

66°
64°
62°
60°
58°
56°
54°
52°
50°
48°
46°
44°
2G
2H
2J
3K
3L
3M
3N
3O
3Ps
Labrador
Shelf
LABRADOR
Northeast
Newfoundland
Shelf
NF
Grand Bank
Flemish
Cap
Depth (m)
100
300
1000

Fig. 1a. Map of the Labrador-Newfoundland area, illustrating major geographic features and NAFO Divisions and Subdivisions.

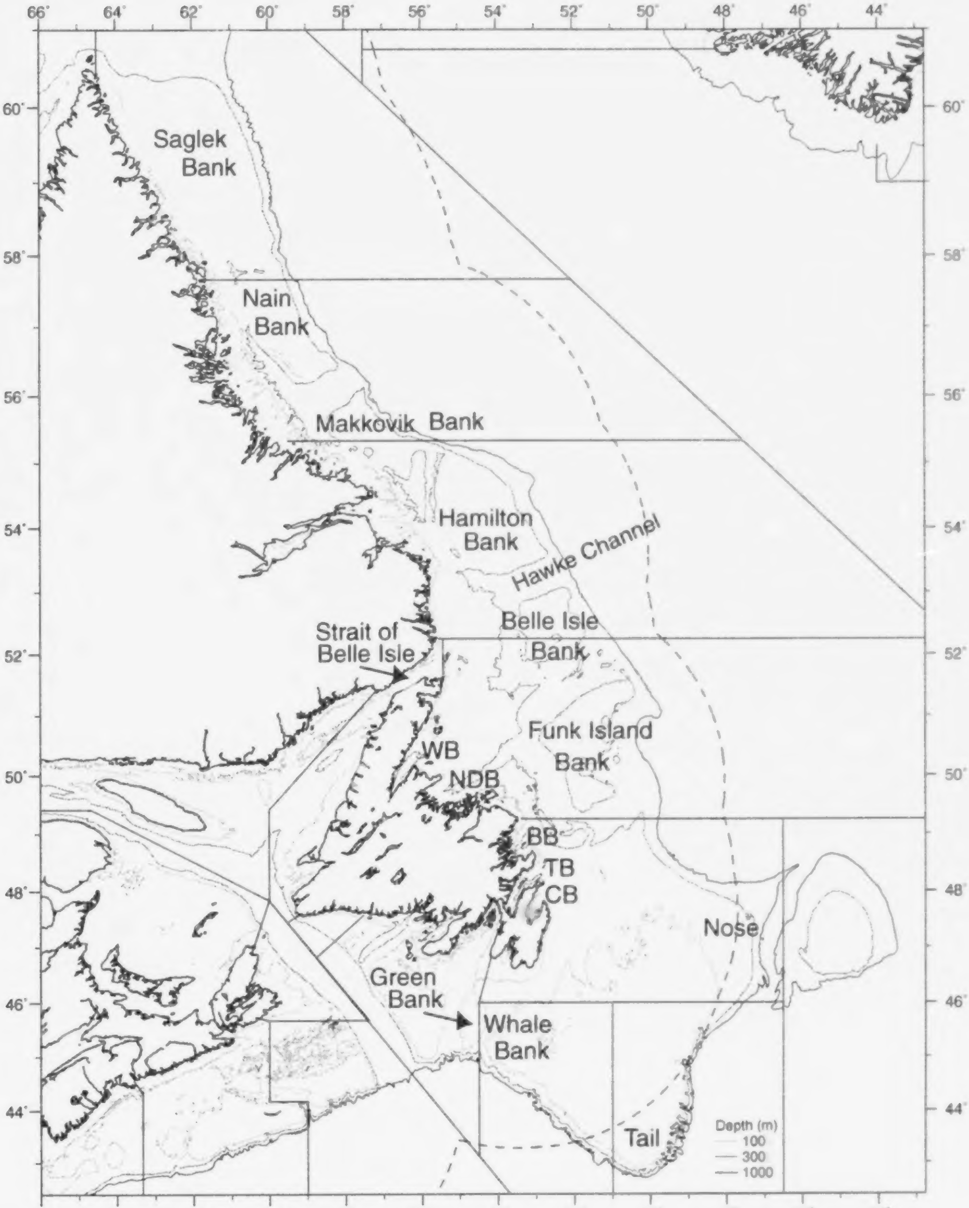

66°
64°
62°
60°
58°
56°
54°
52°
50°
48°
46°
44°
60°
58°
56°
54°
52°
50°
48°
46°
44°
Saglek Bank
Nain Bank
Makkovik Bank
Hamilton Bank
Hawke Channel
Strait of Belle Isle
Belle Isle Bank
Funk Island Bank
WB
NDB
BB
TB
CB
Nose
Green Bank
Whale Bank
Tail
Depth (m)
100
300
1000

Fig. 1b. Map of the Labrador-Newfoundland area, illustrating the location of Canada's 200 nautical mile limit and various banks and bays. The bays, from north to south, are White Bay (WB), Notre Dame Bay (NDB), Bonavista Bay (BB), Trinity Bay (TB) and Conception Bay (CB).

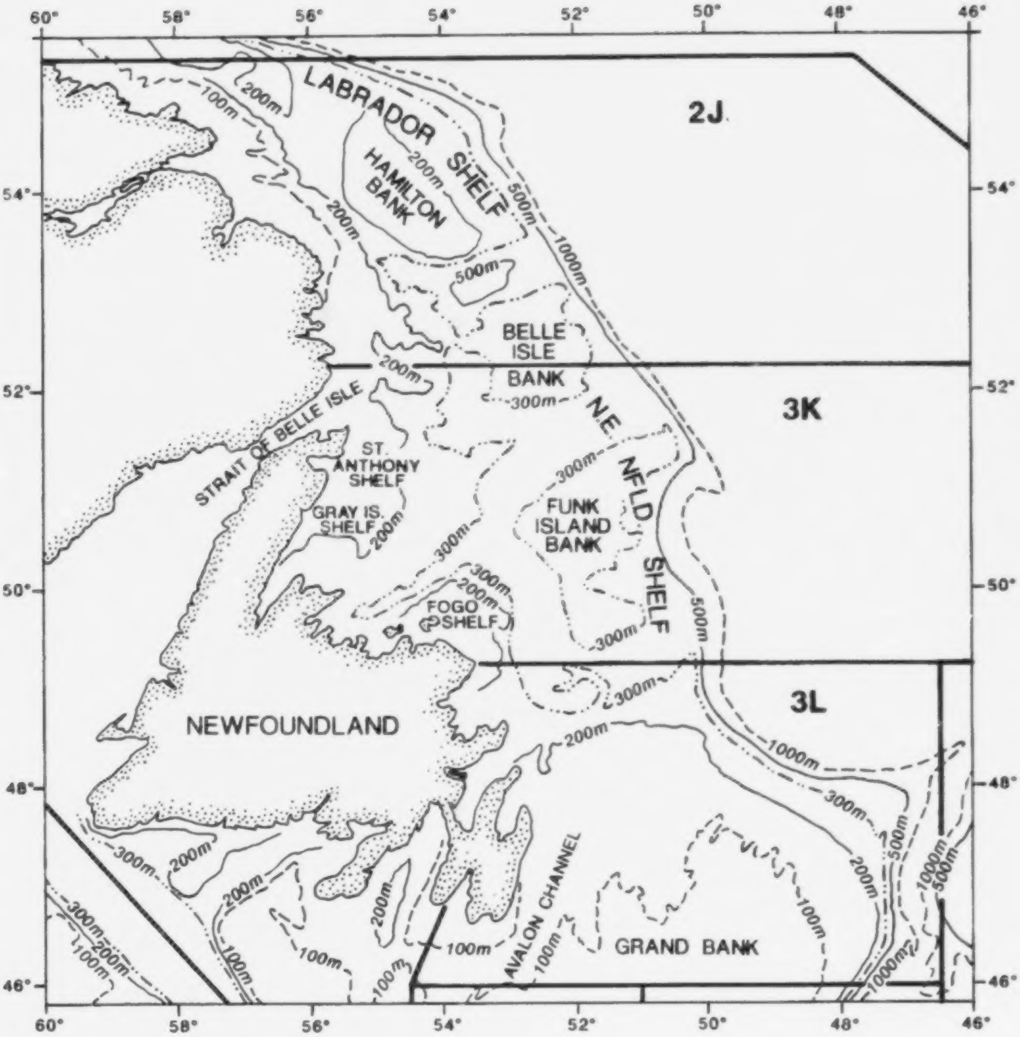

60°
58°
56°
54°
52°
50°
48°
46°
54°
52°
50°
48°
46°
2J
3K
3L
LABRADOR SHELF
HAMILTON BANK
BELLE ISLE BANK
N.E. NFLD. SHELF
STRAIT OF BELLE ISLE
ST. ANTHONY SHELF
GRAY IS. SHELF
FUNK ISLAND BANK
FOGO SHELF
NEWFOUNDLAND
AVALON CHANNEL
GRAND BANK
100m
200m
300m
500m
1000m

Fig. 1c. Map of the 2J3KL cod stock area, showing physiographic features and NAFO Divisions.

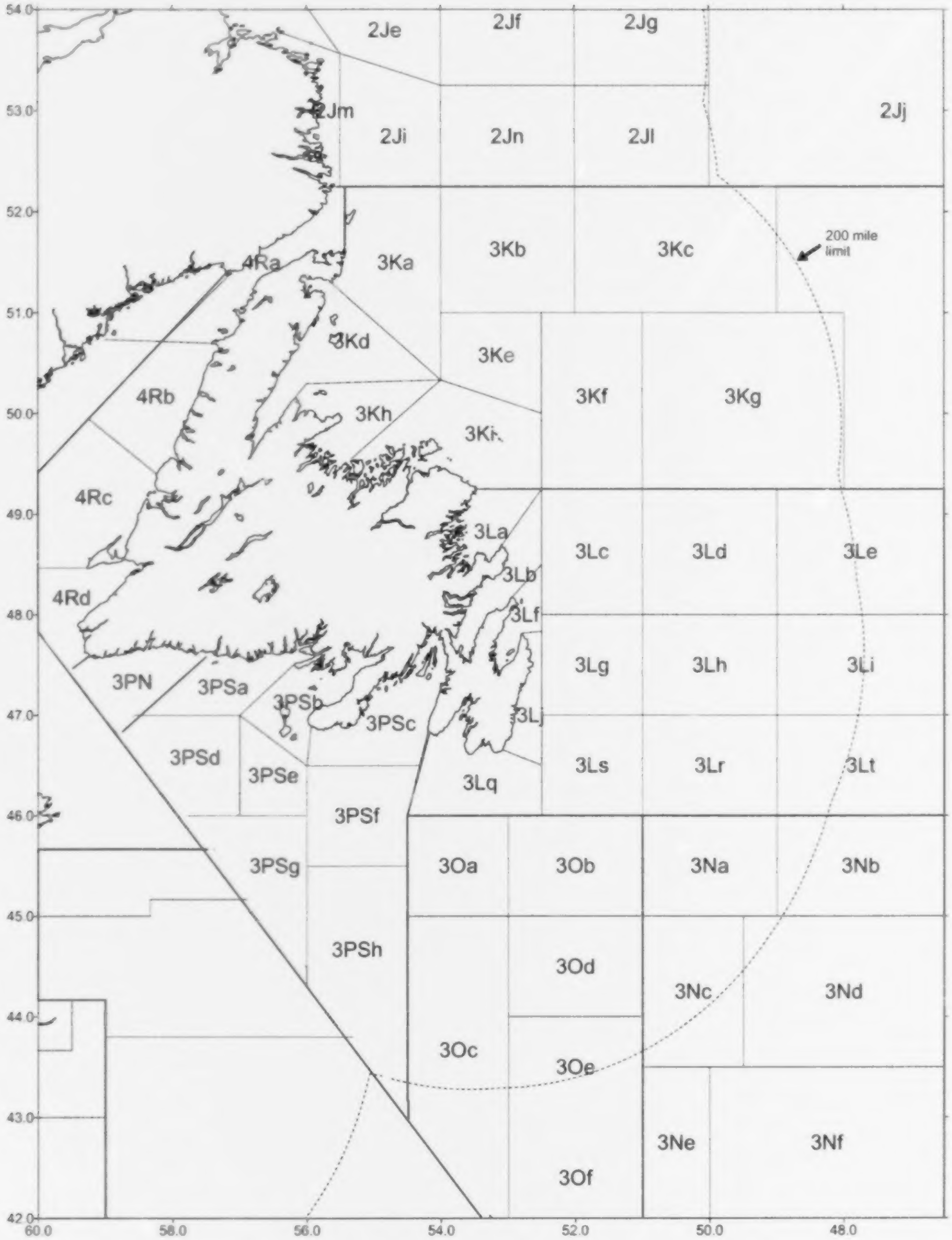

54.0
53.0
52.0
51.0
50.0
49.0
48.0
47.0
46.0
45.0
44.0
43.0
42.0
60.0
58.0
56.0
54.0
52.0
50.0
48.0
2Je
2Jf
2Jg
2Jm
2Ji
2Jn
2Jl
2Jj
3Ka
3Kb
3Kc
200 mile limit
4Ra
3Kd
3Ke
4Rb
3Kh
3Kf
3Kg
3Ki
4Rc
3La
3Lc
3Ld
3Le
3Lb
4Rd
3Lf
3Lg
3Lh
3Li
3PN
3PSa
3PSb
3Lj
3PSc
3PSd
3PSe
3Ls
3Lr
3Lt
3Lq
3PSf
3PSg
3Oa
3Ob
3Na
3Nb
3PSh
3Od
3Nc
3Nd
3Oc
3Oe
3Ne
3Nf
3Of

Fig. 1d. Map of the 2J3KL cod stock area, showing commercial fishery statistical unit areas.

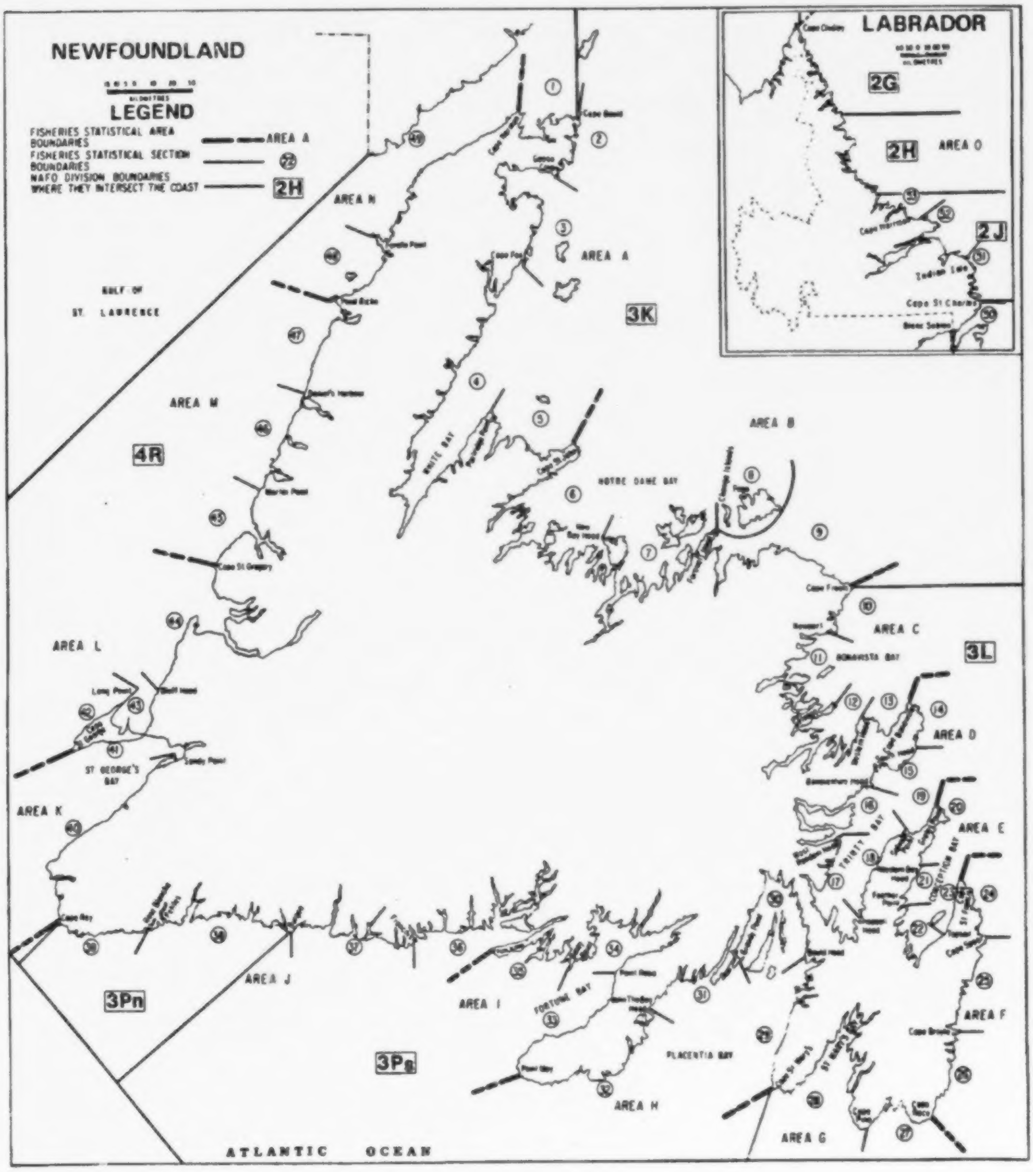

NEWFOUNDLAND
LEGEND
FISHERIES STATISTICAL AREA BOUNDARIES
AREA A
FISHERIES STATISTICAL SECTION BOUNDARIES
22
NAFO DIVISION BOUNDARIES WHERE THEY INTERSECT THE COAST
2H
LABRADOR
Cape Chidley
2G
2H
AREA O
2J
Cape Harrison
Cape St Charles
Blanc Sablon
53
52
51
50
GULF OF ST. LAWRENCE
AREA A
AREA B
AREA C
AREA D
AREA E
AREA F
AREA G
AREA H
AREA I
AREA J
AREA K
AREA L
AREA M
AREA N
3K
3L
3Pn
3Ps
4R
Cape Bauld
WHITE BAY
NOTRE DAME BAY
BONAVISTA BAY
TRINITY BAY
CONCEPTION BAY
PLACENTIA BAY
FORTUNE BAY
ST GEORGE'S BAY
Cape St Gregory
Cape Freels
Cape Ray
Cape Race
ATLANTIC OCEAN

Fig. 1e. Map of the 2J3KL cod stock area, showing commercial fishery areas and statistical sections.

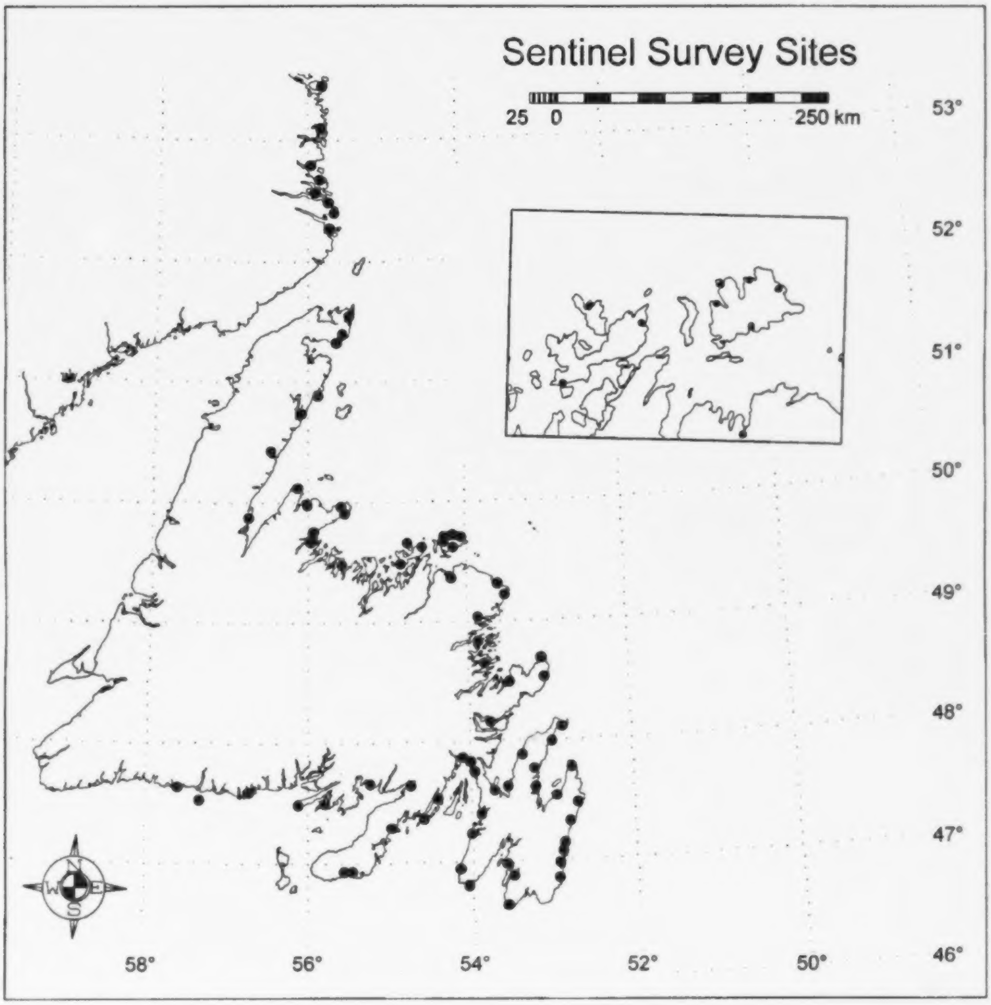

Sentinel Survey Sites
25
0
250 km
53°
52°
51°
50°
49°
48°
47°
46°
58°
56°
54°
52°
50°
N
W
E
S

Fig. 1f. Map of the 2J3KL cod stock area, showing sentinel survey sites.

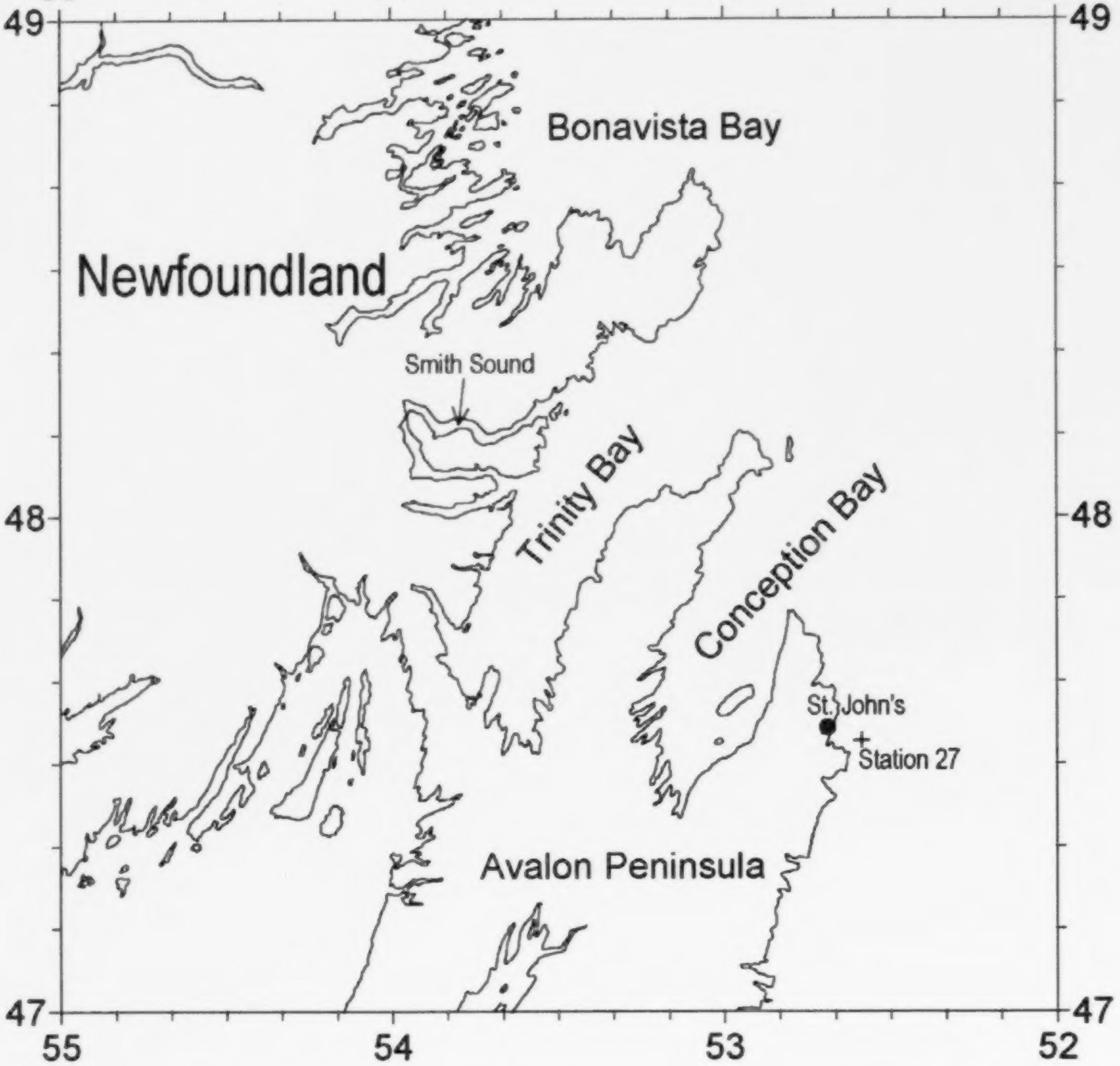

55
54
53
52
49
48
47
Bonavista Bay
Newfoundland
Smith Sound
Trinity Bay
Conception Bay
St. John's
Station 27
Avalon Peninsula

Fig. 1g. Map of the east coast of Newfoundland, indicating the location of Smith Sound within Trinity Bay and oceanographic Station 27 off St. John's.

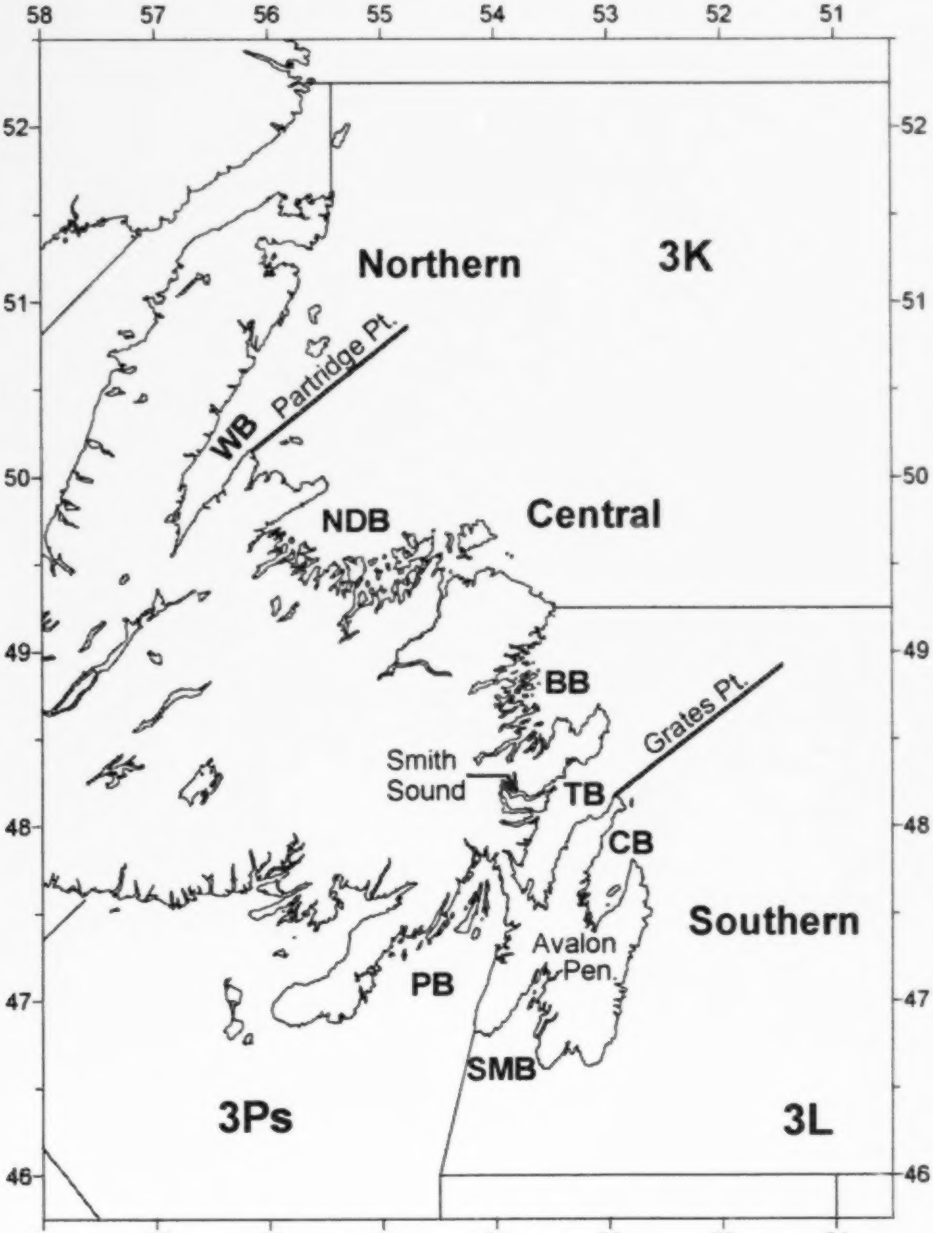

58
57
56
55
54
53
52
51
52
51
50
49
48
47
46
Northern
3K
Partridge Pt.
WB
NDB
Central
BB
Grates Pt.
Smith Sound
TB
CB
Southern
Avalon Pen.
PB
SMB
3Ps
3L

Fig. 1h. Map of the inshore of eastern Newfoundland, indicating the locations of the northern, central and southern inshore areas as defined for the present assessment. Also indicated are the locations of Smith Sound, the Avalon Peninsula, and the major bays: White Bay (WB), Notre Dame Bay (NDB), Bonavista Bay (BB), Trinity Bay (TB), Conception Bay (CB) and St. Mary's Bay (SMB). Placentia Bay (PB) is in Subdiv. 3Ps.

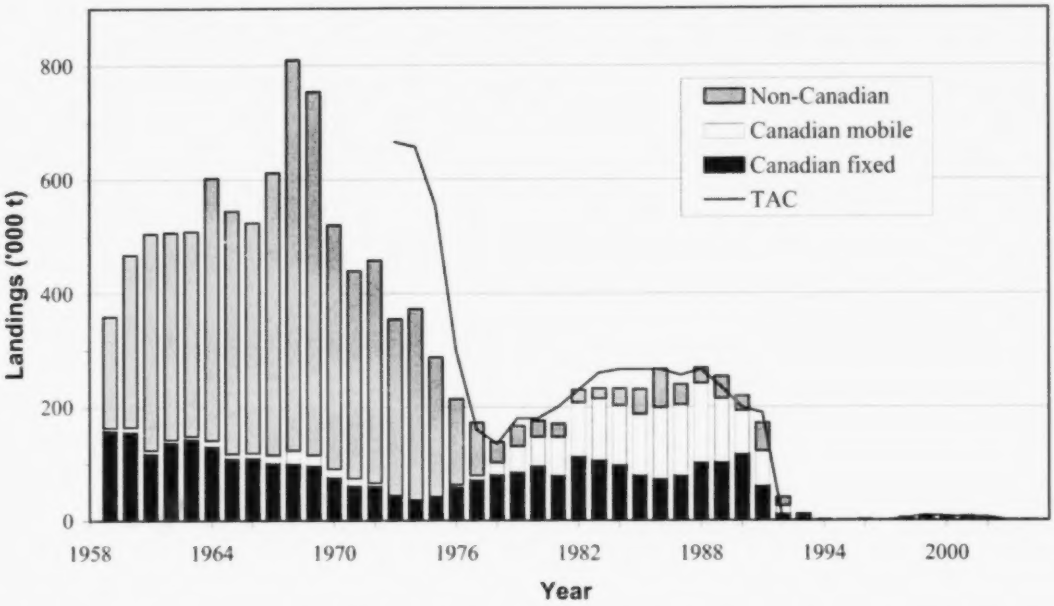


Fig. 2. Cod in Div. 2J3KL. Total allowable catches (TACs) and landings (thousands of tons) by non-Canadian fleets and Canadian fleets, with the latter divided into mobile gear (offshore) and fixed gear (mainly inshore).

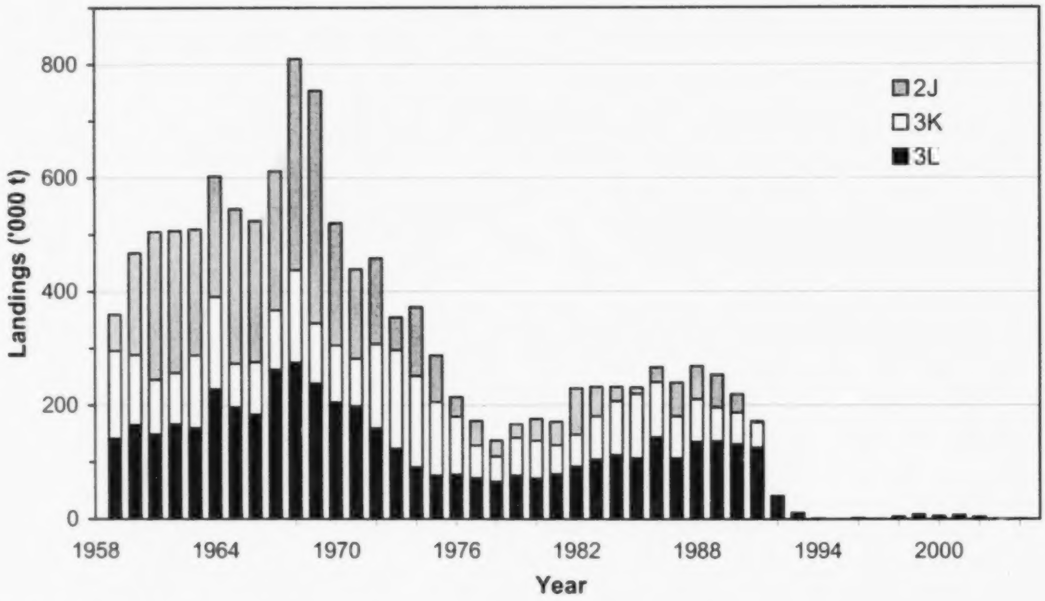


Fig. 3. Cod in Div. 2J3KL. Landings (thousands of tons) by Division.

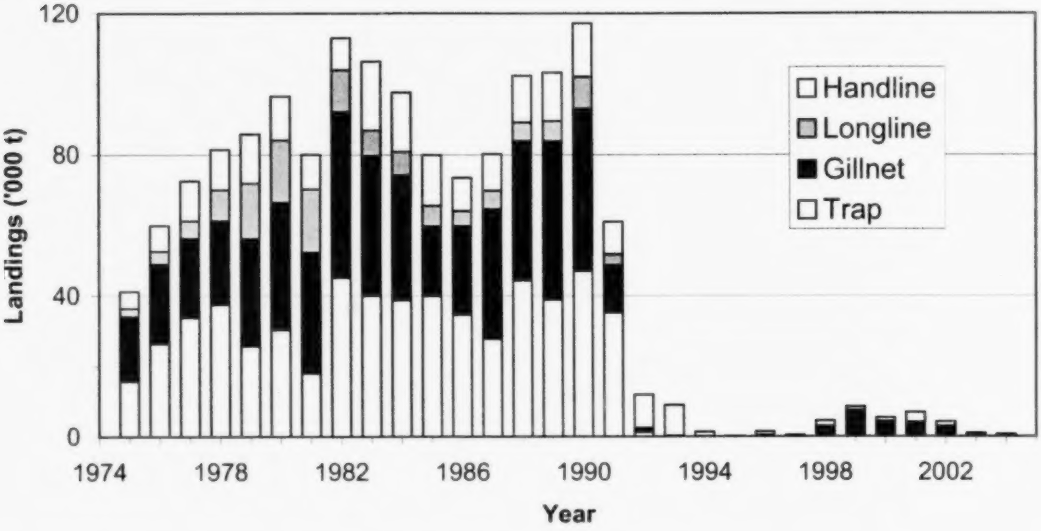


Fig. 4. Cod in Div. 2J3KL. Fixed gear landings (thousands of tons) by gear type.

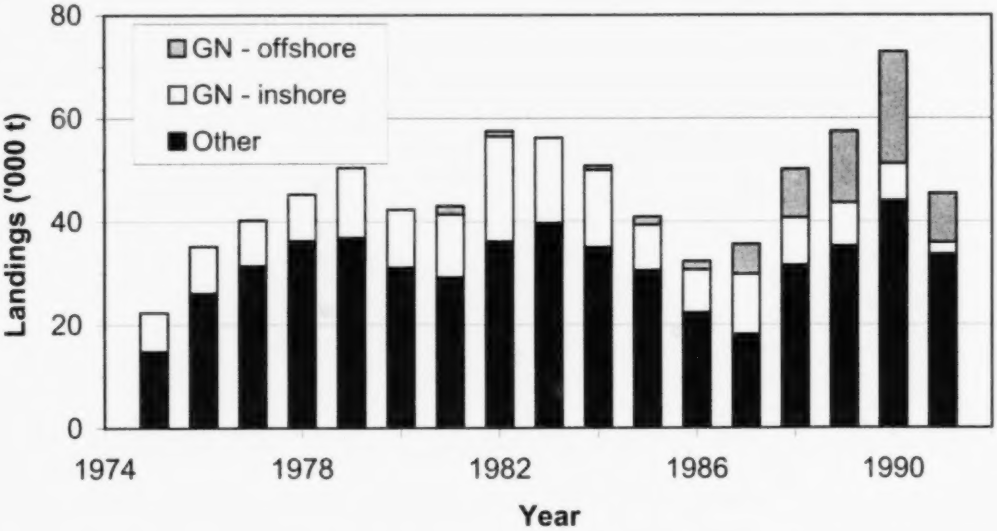


Fig. 5. Cod in Div. 3L. Fixed gear landings (thousands of tons) in Div. 3L (1975-1991), highlighting landings by gillnet and by other gears combined, with the gillnet landings subdivided into inshore and offshore.

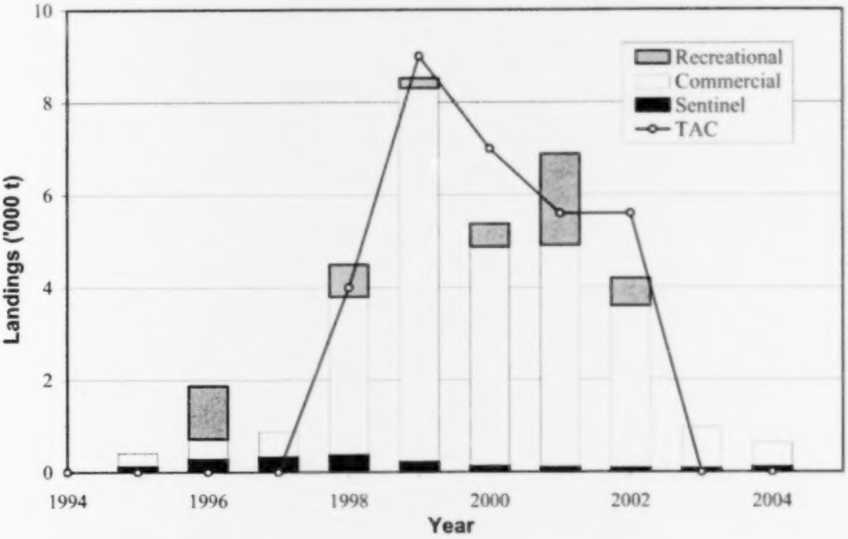


Fig. 6. Cod in Div. 2J3KL. Total allowable catches (TACs) and inshore fixed-gear landings (thousands of tons) for the inshore fishery (1995-2004). The landings are subdivided into sentinel, index/commercial (including by-catch) and food/recreational. Most of the landings in 2003 came from a mass mortality of cod in Smith Sound, Trinity Bay in April.

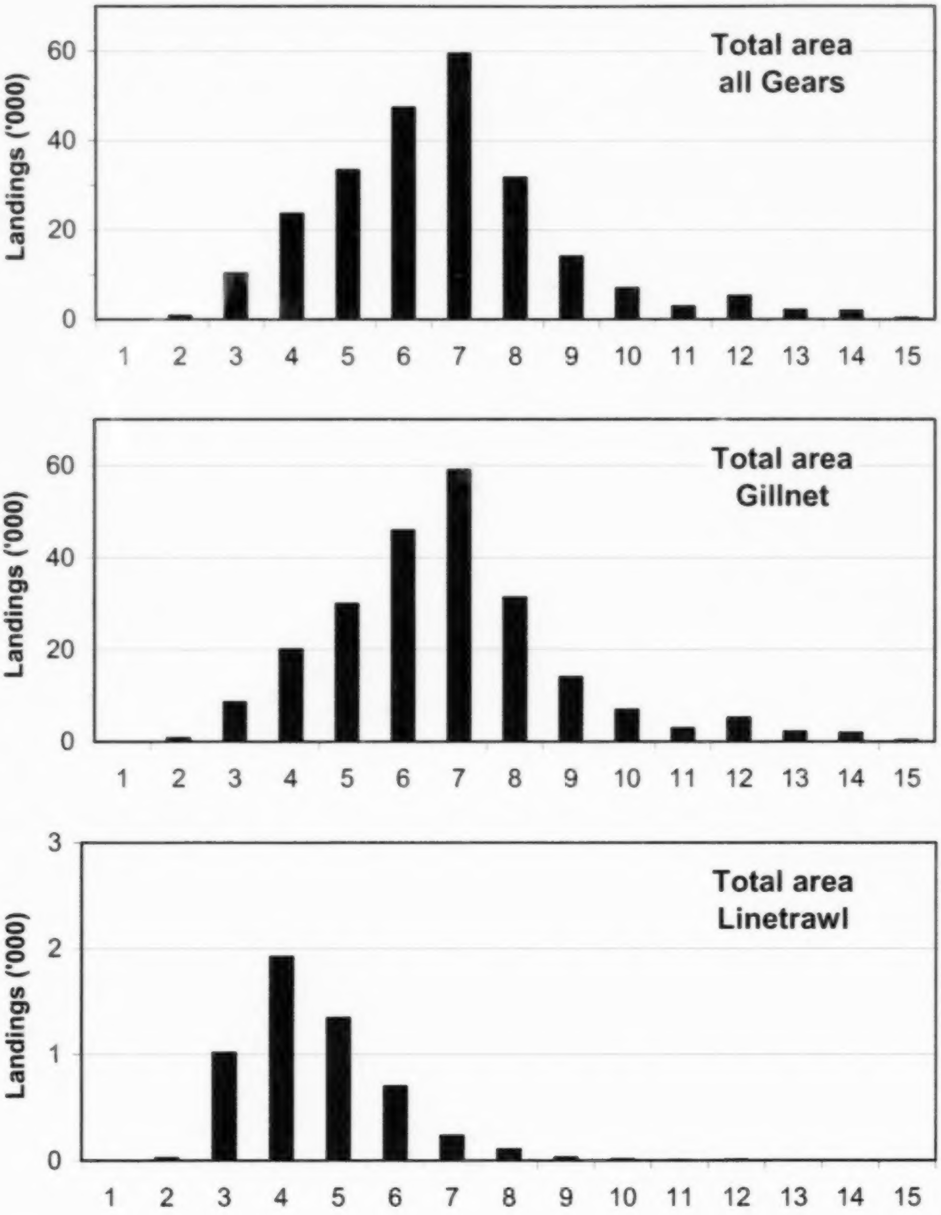


Fig. 7a. The estimated catch at age, all gears combined and gillnet and linetrawl separately, in 2004.

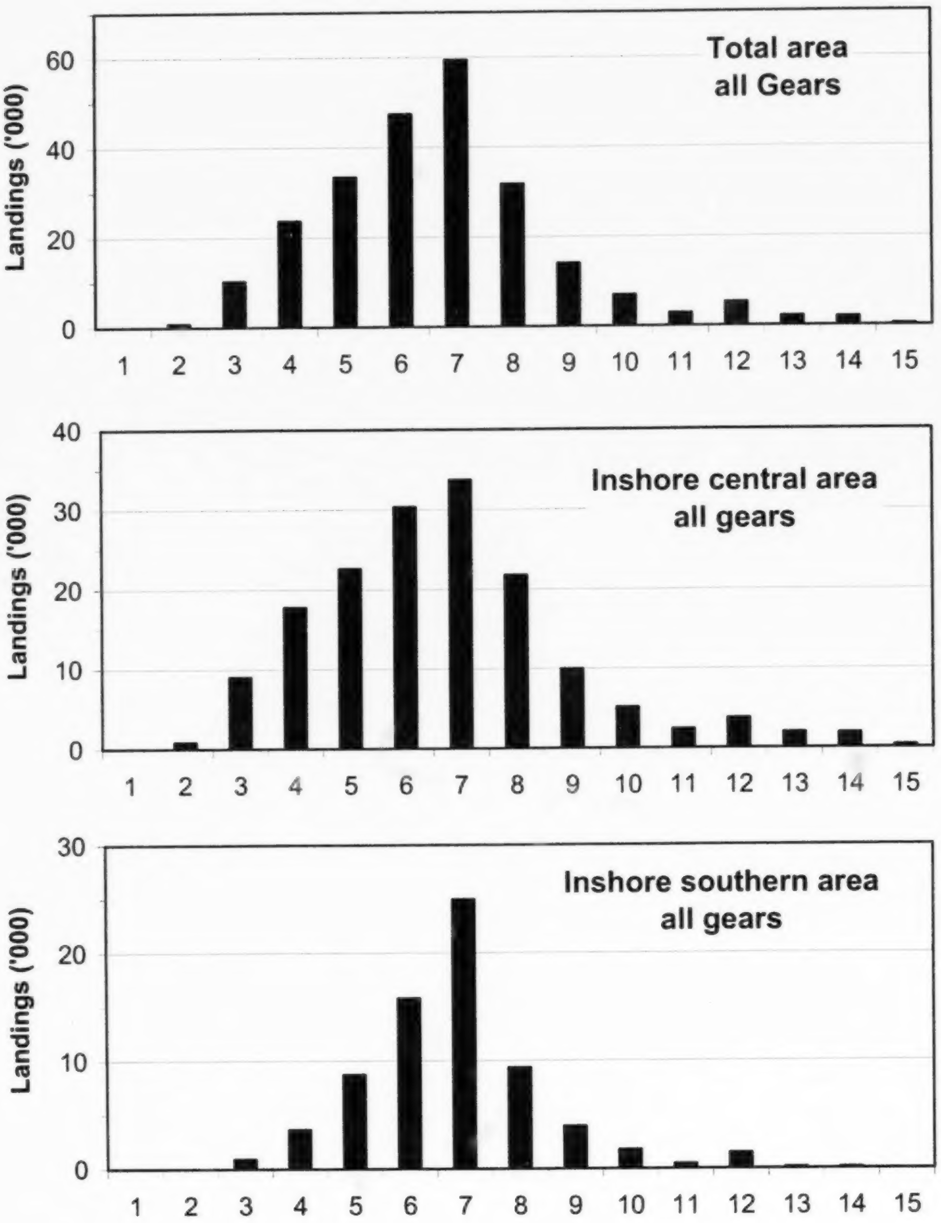


Fig. 7b. The estimated catch at age, all gears combined, in 2004. The upper panel illustrates the catch from the whole of 2J3KL. The middle and lower panels illustrate the catch in the central and southern inshore areas as defined for the present assessment.

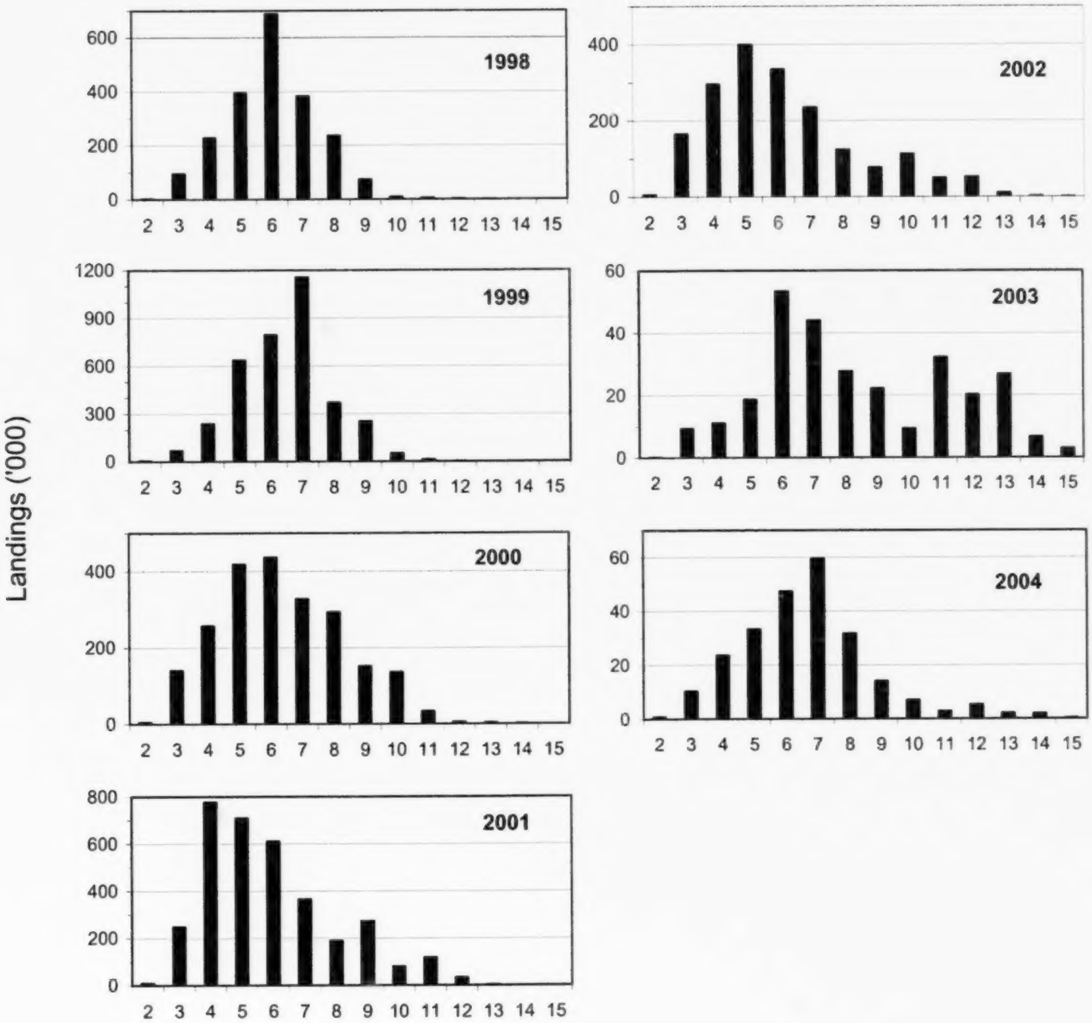


Fig. 8. The estimated catch at age for all gears combined in 1998-2004.

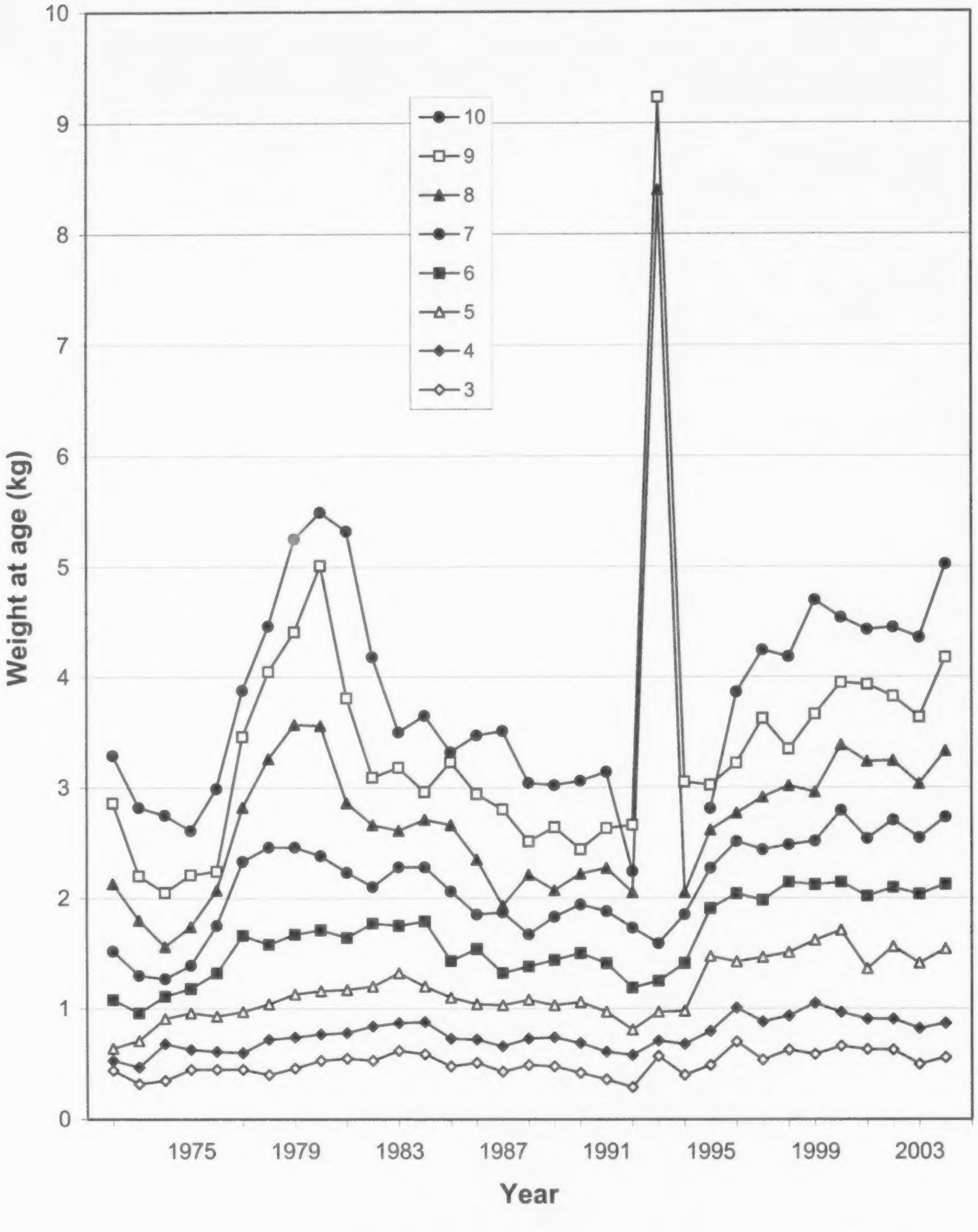


Fig. 9. Mean weights-at-age calculated from mean lengths-at-age in the catch, 1972-2004.

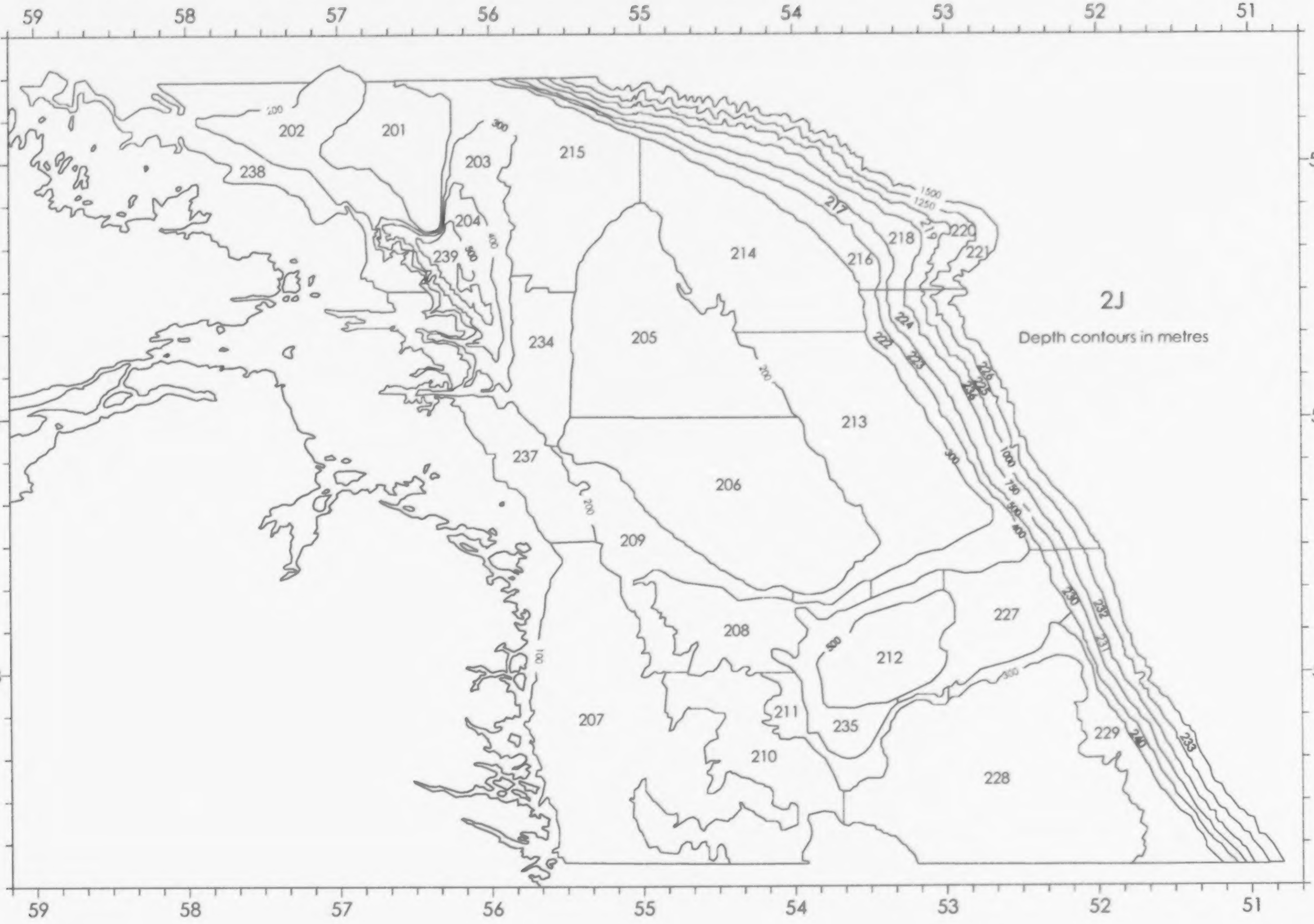

59
58
57
56
55
54
53
52
51
55
54
53
2J
Depth contours in metres
201
202
203
204
205
206
207
208
209
210
211
212
213
214
215
216
217
218
219
220
221
222
223
224
225
226
227
228
229
230
231
232
233
234
235
236
237
238
239
240
100
200
300
400
500
750
1000
1250
1500

Fig. 10. Strata used for research bottom-trawl surveys in Division 2J.

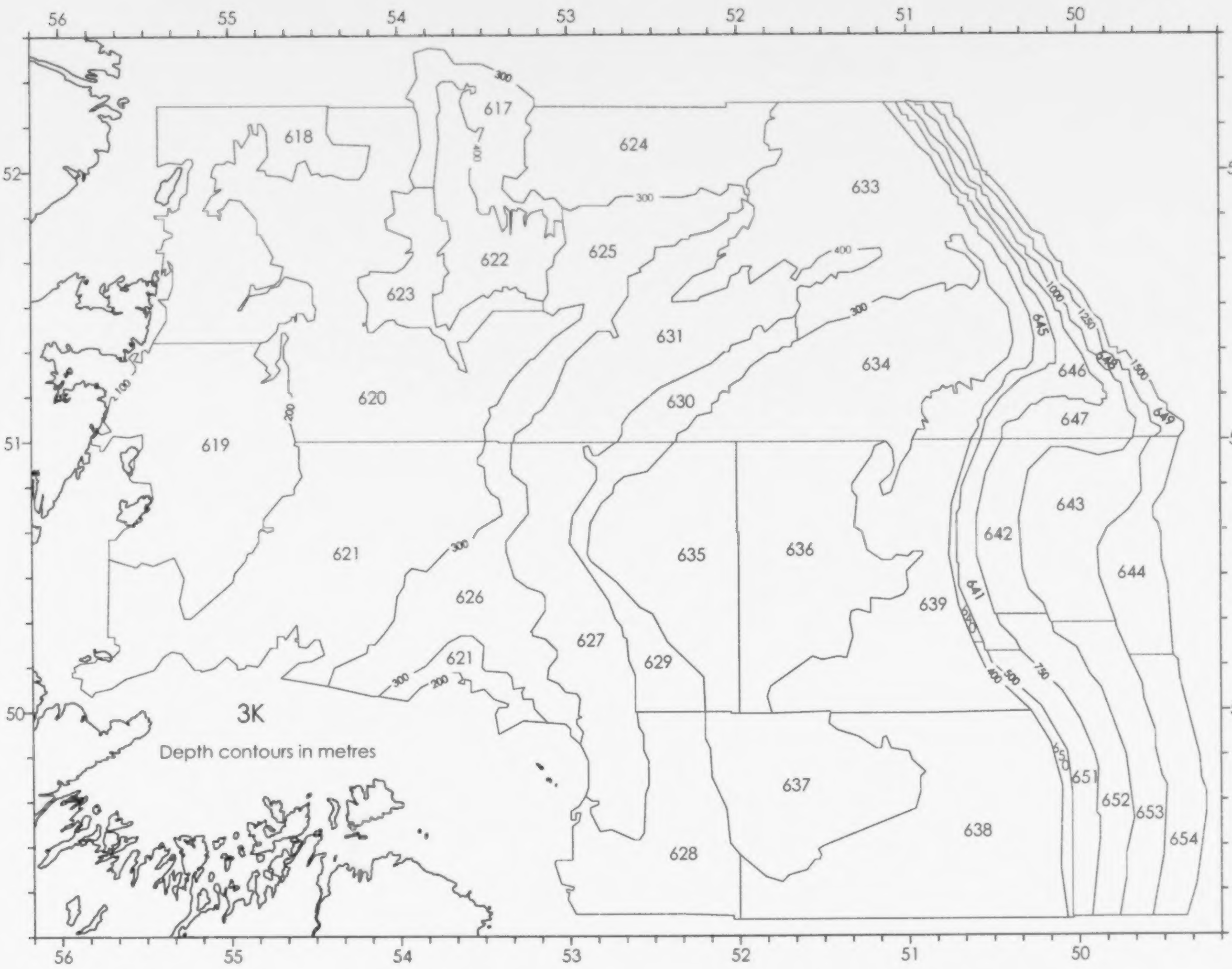
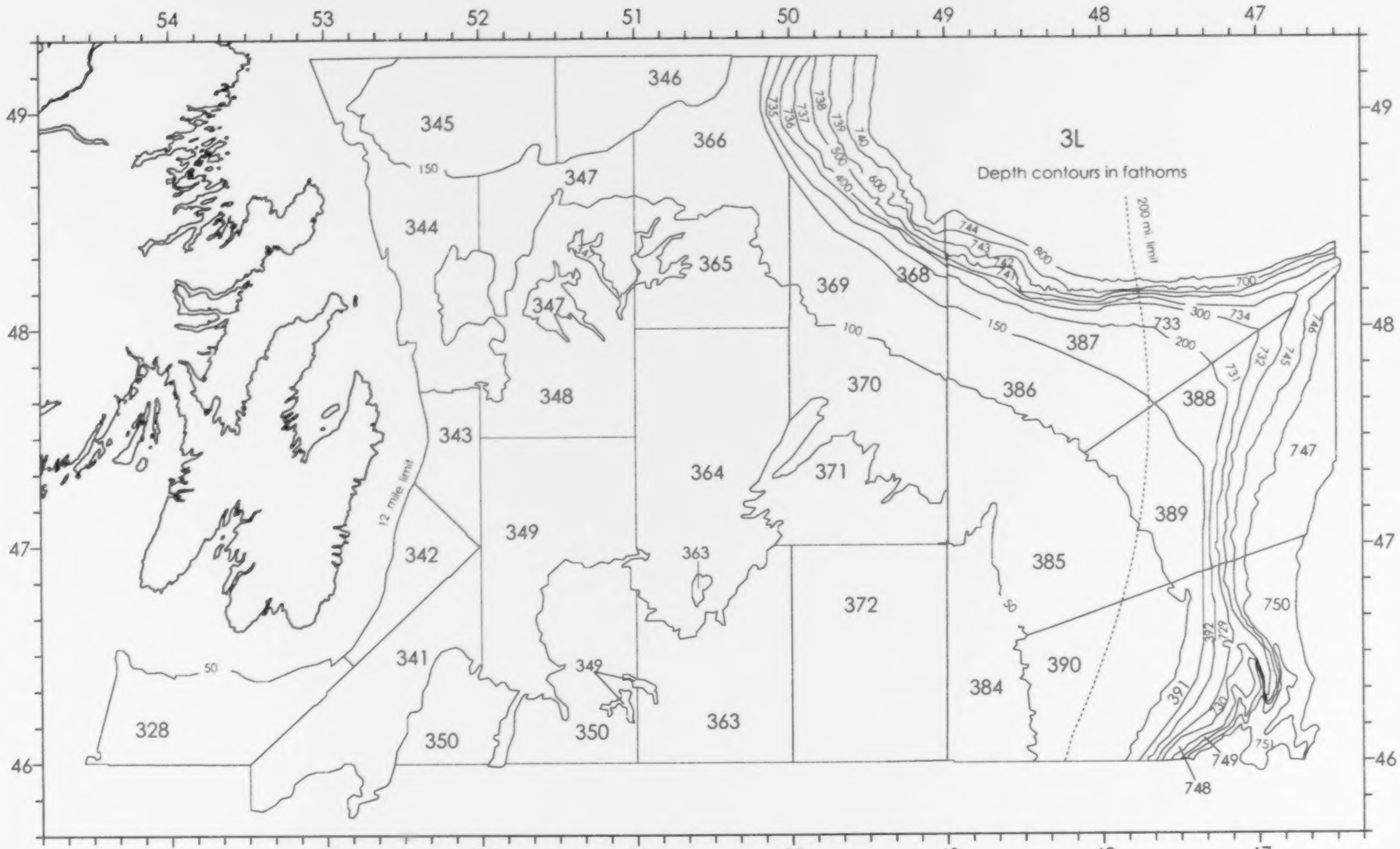

56
55
54
53
52
51
50
52
51
50
3K
Depth contours in metres
617
618
619
620
621
622
623
624
625
626
627
628
629
630
631
633
634
635
636
637
638
639
641
642
643
644
645
646
647
648
649
650
651
652
653
654
100
200
300
400
500
750
1000
1250
1500

Fig. 11. Strata used for research bottom-trawl surveys in Division 3K.


3L
Depth contours in fathoms
200 mi. limit
12 mile limit
54
53
52
51
50
49
48
47
49
48
47
46
328
341
342
343
344
345
346
347
348
349
350
363
364
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392
729
730
731
732
733
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751
50
100
150
200
300
400
500
600
700
800

Fig. 12. Strata used for research bottom-trawl surveys in Division 3L.

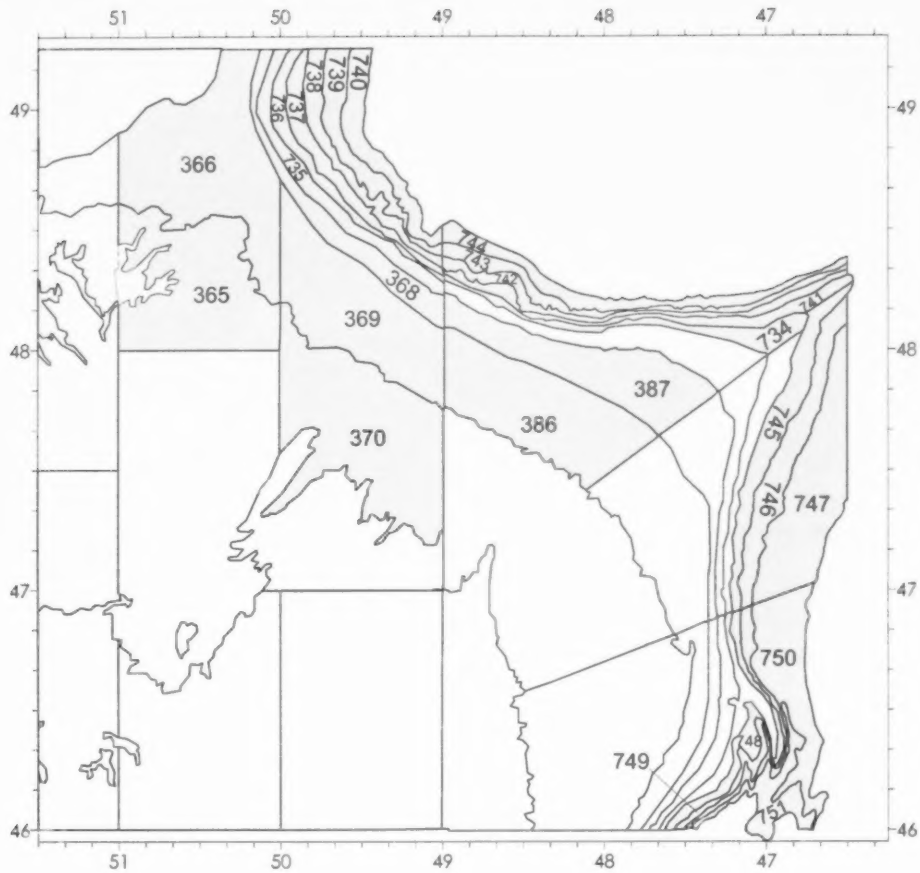

51
50
49
48
47
49
48
47
46
366
365
369
370
368
386
387
734
735
736
737
738
739
740
741
742
743
744
745
746
747
748
749
750
751

Fig. 13. Strata on the eastern side of Div. 3L. Those indicated by shading and numbering were not surveyed during the 2004 autumn research bottom-trawl survey.

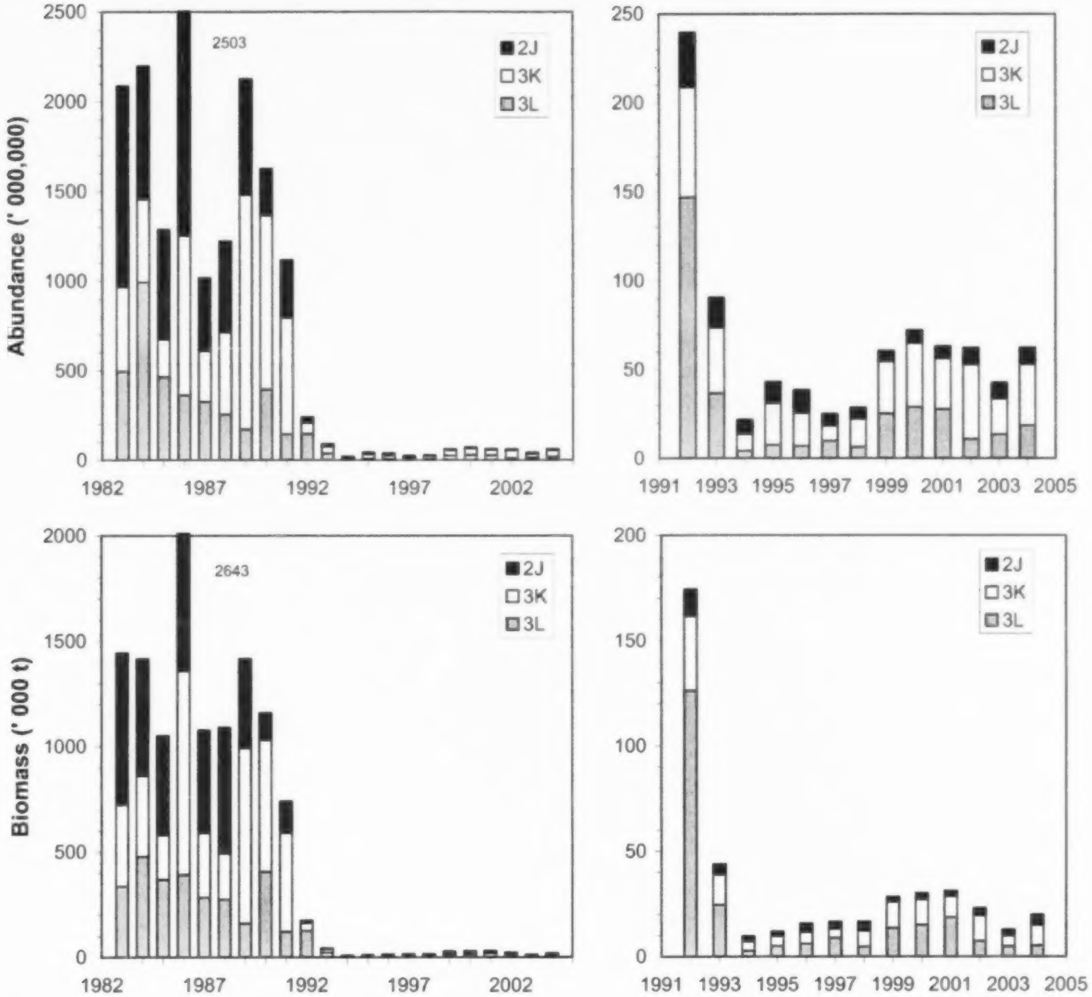


Figure 14. Trend in the index of population abundance (above) and biomass (below) computed by areal expansion of the stratified arithmetic mean catch per tow during autumn bottom-trawl surveys in 2J3KL. The scales on the right panels illustrate just the lower 10% of the left panels, in order that data from 1992-2004 may be more readily discerned. Note that the survey trawl was changed in 1995, and data collected prior to 1995 have been converted so as to be equivalent to data collected from 1995 onward.

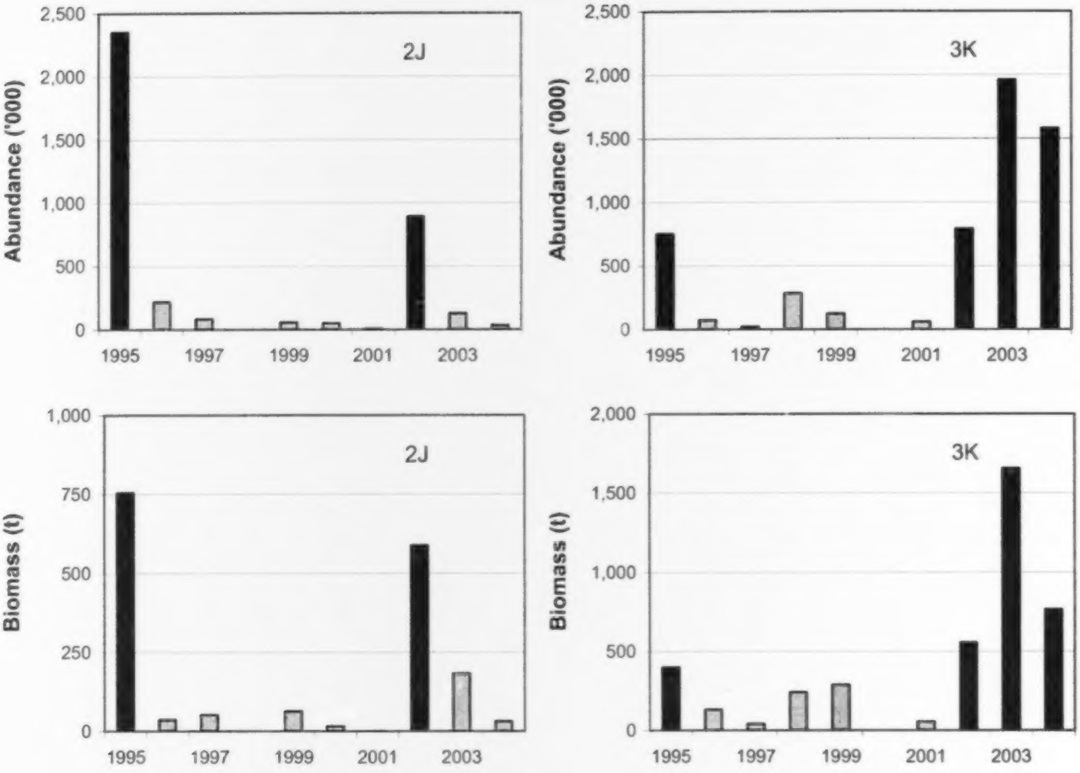
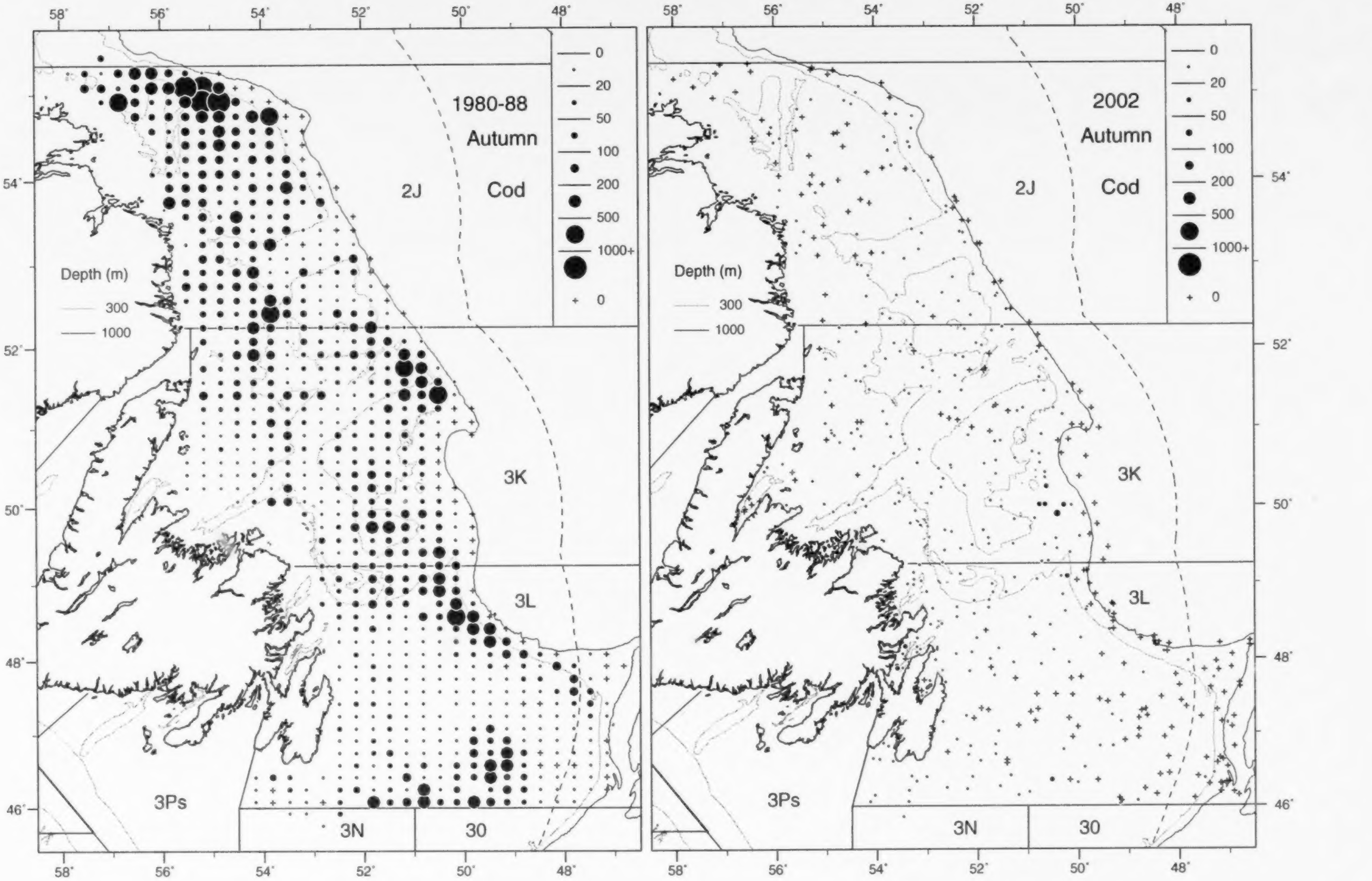


Fig. 15. Indices of abundance (top) and biomass (bottom) of cod in strata deeper than 500 m during autumn bottom-trawl surveys in divisions 2J (left) and 3K (right). Years highlighted in black are those in which at least some strata were fished after December. Only years since the introduction of the Campelen trawl are illustrated.



1980-88
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
20
50
100
200
500
1000+
0
2002
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
20
50
100
200
500
1000+
0
58°
56°
54°
52°
50°
48°
54°
52°
50°
48°
46°

Fig. 16. Cod distribution (kg per standard tow) during the autumn surveys in divisions 2J3KL. The left panel (from Lilly 1994) illustrates the average catch per 30 min tow with the Engels trawl within areas of 10' latitude amd 20' longitude. All tows during 1980-1988 were combined. The right panel shows the catches per 15 min tow with the Campelen trawl during 2002.

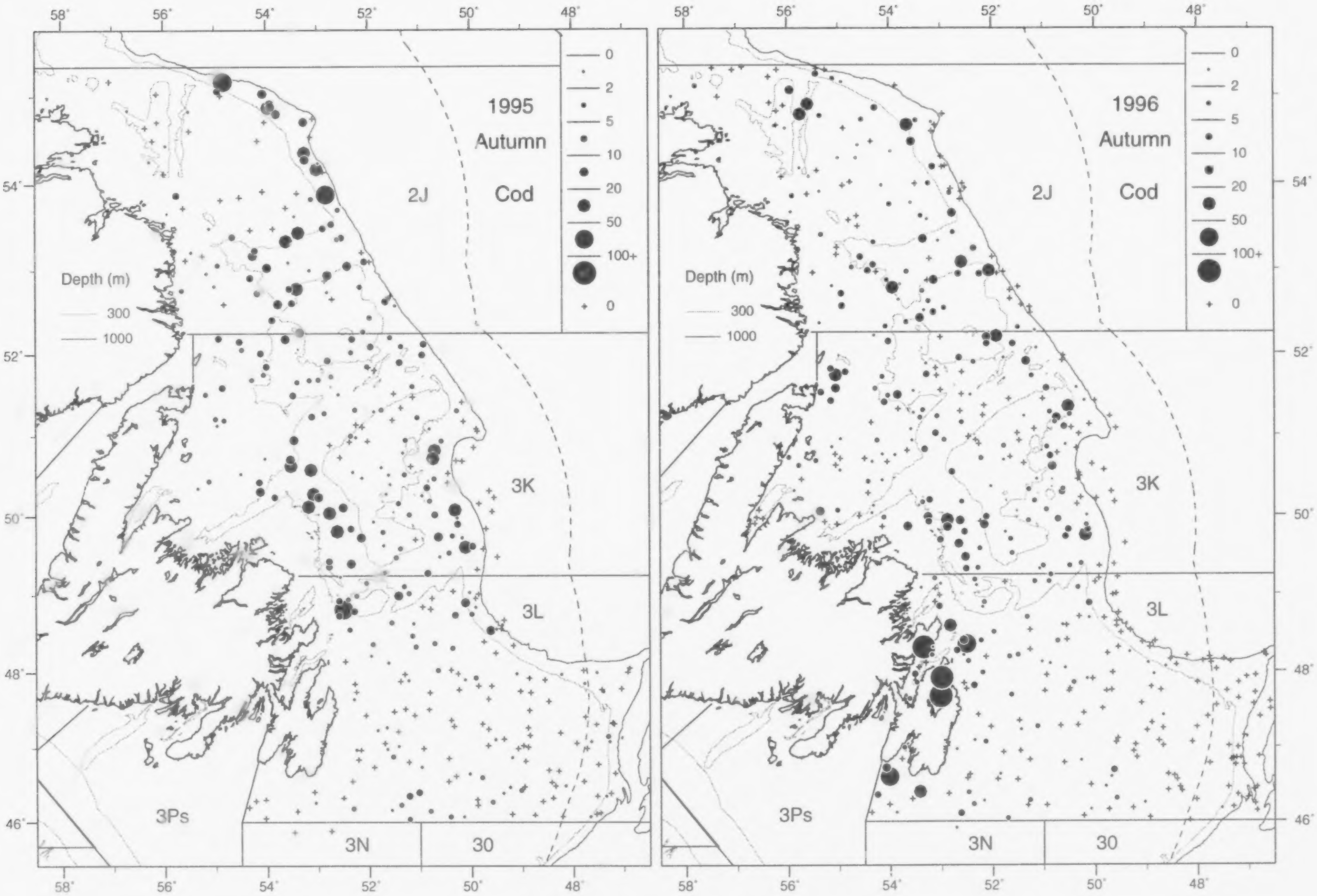

1995
Autumn
Cod
1996
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
58°
56°
54°
52°
50°
48°
46°

Fig. 17a. Cod distribution (number per standard tow) during the autumn surveys in divisions 2J3KL in 1995 and 1996.

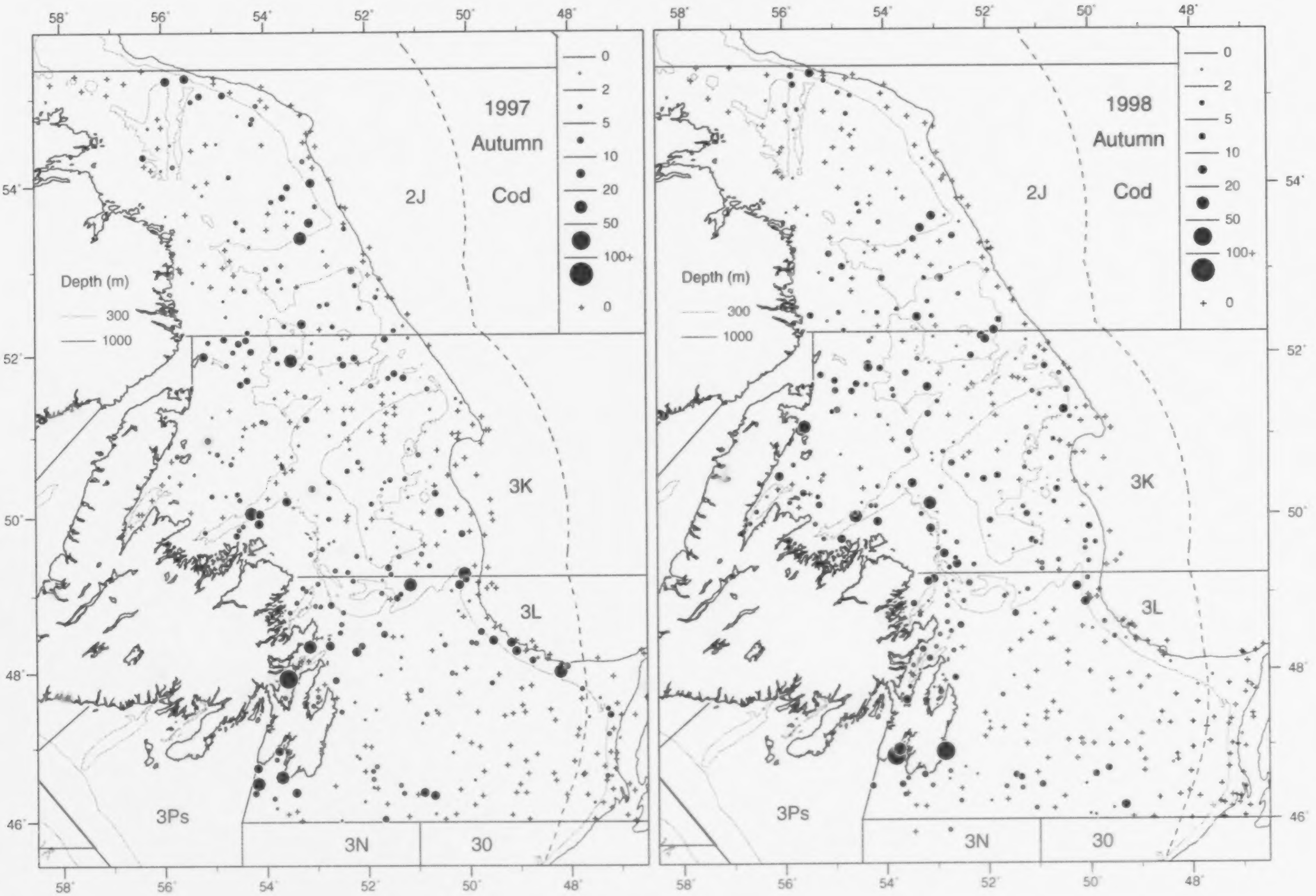

1997
Autumn
Cod
1998
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
58°
56°
54°
52°
50°
48°
46°

Fig. 17b. Cod distribution (number per standard tow) during the autumn surveys in divisions 2J3KL in 1997 and 1998.

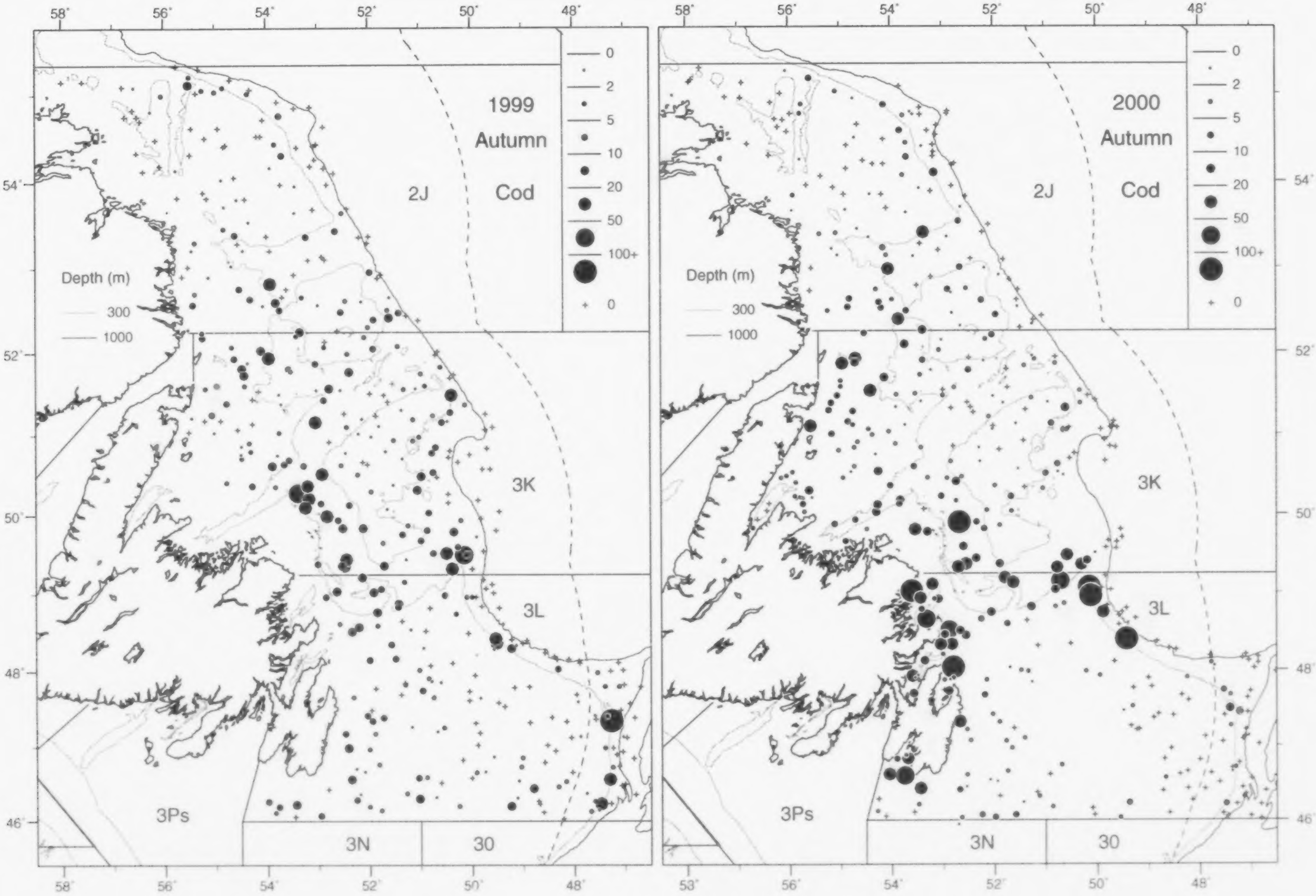

58°
56°
54°
52°
50°
48°
1999
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
54°
52°
50°
48°
46°
2000
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
54°
52°
50°
48°
46°

Fig. 17c. Cod distribution (number per standard tow) during the autumn surveys in divisions 2J3KL in 1999 and 2000.

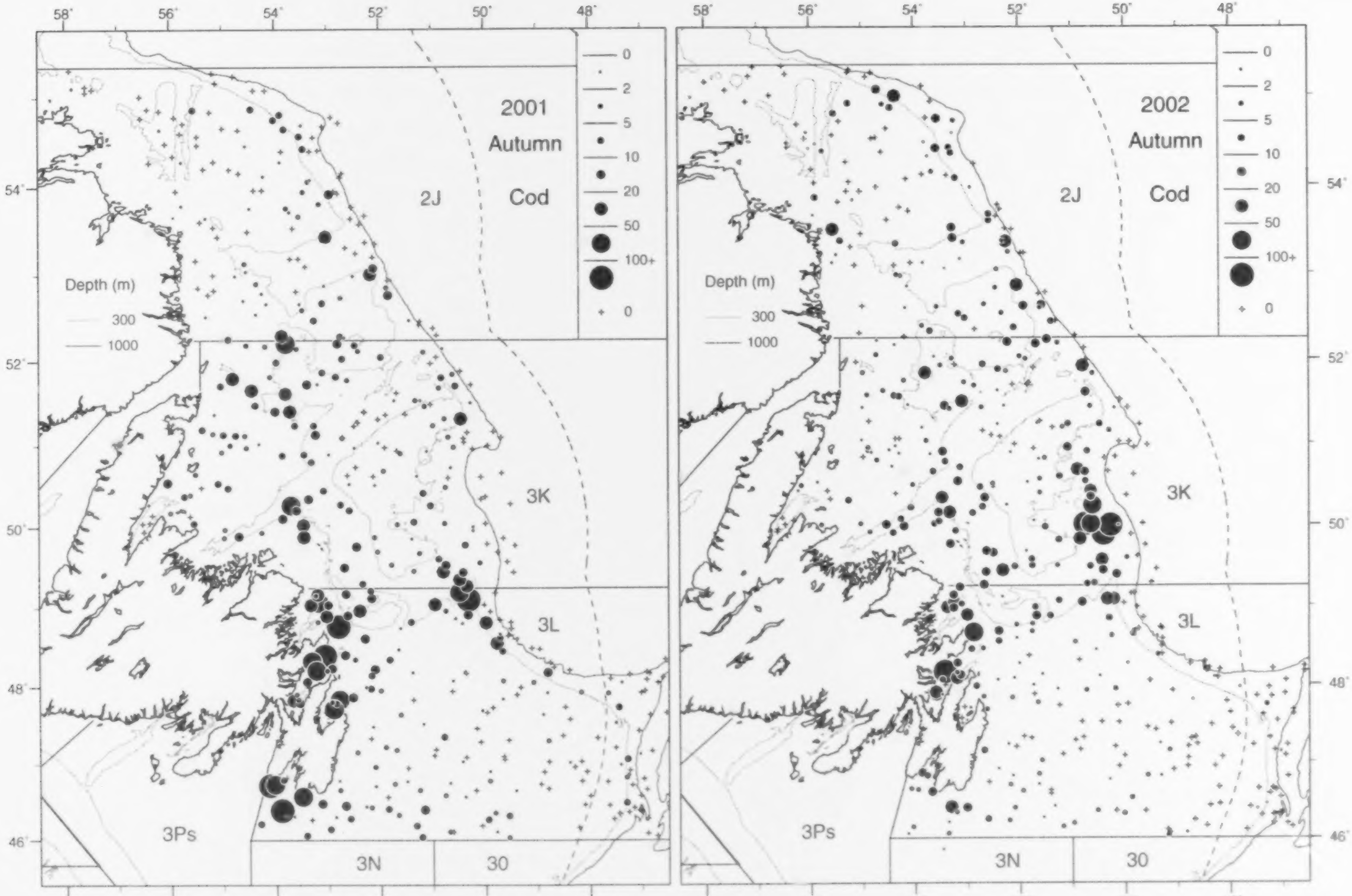

2001
Autumn
Cod
2002
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
58°
56°
54°
52°
50°
48°
46°

Fig. 17d. Cod distribution (number per standard tow) during the autumn survey in divisions 2J3KL in 2001 and 2002.

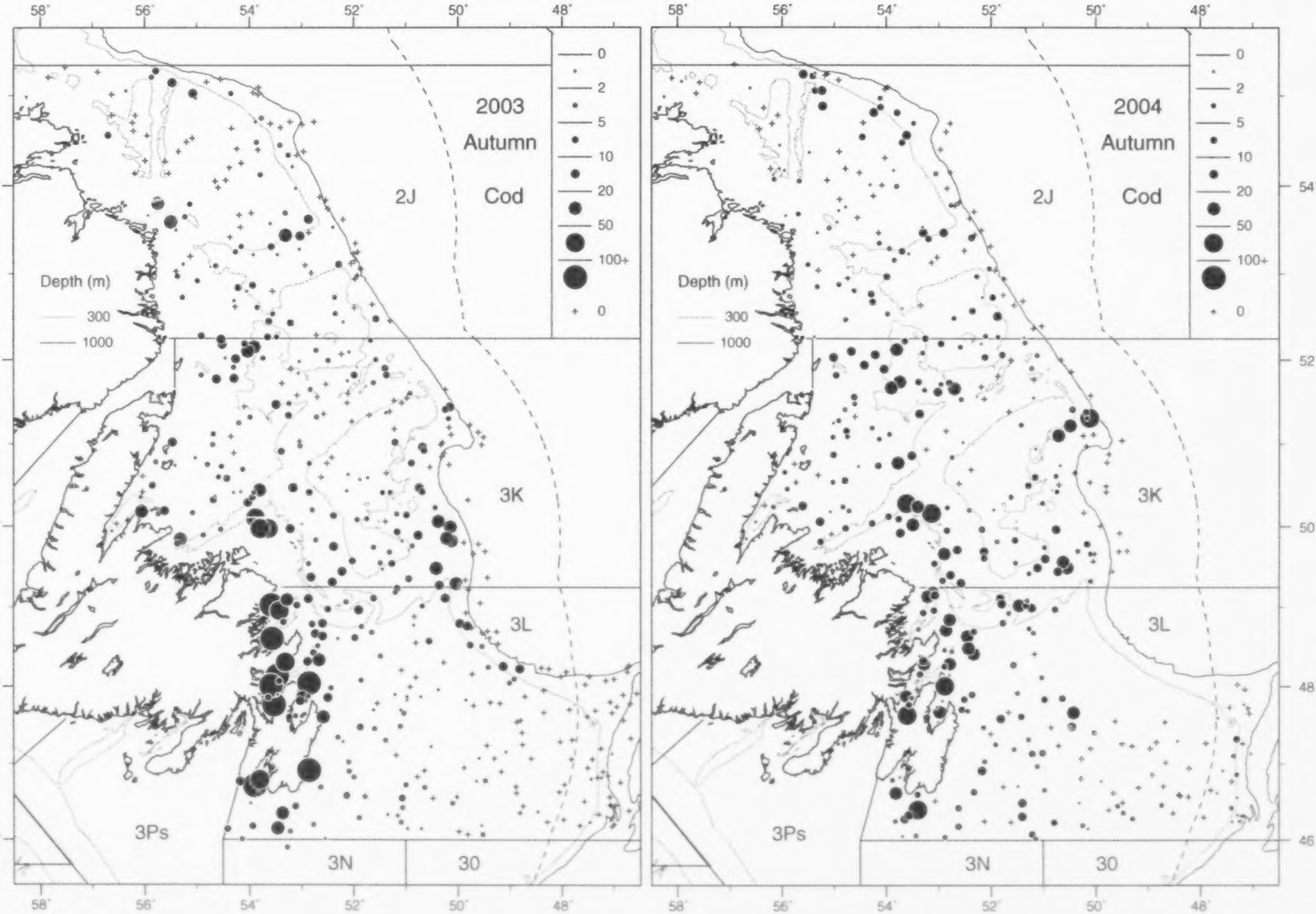

2003
Autumn
Cod
2004
Autumn
Cod
2J
3K
3L
3Ps
3N
3O
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
58°
56°
54°
52°
50°
48°
46°

Fig. 17e. Cod distribution (number per standard tow) during the autumn survey in divisions 2J3KL in 2003 and 2004.

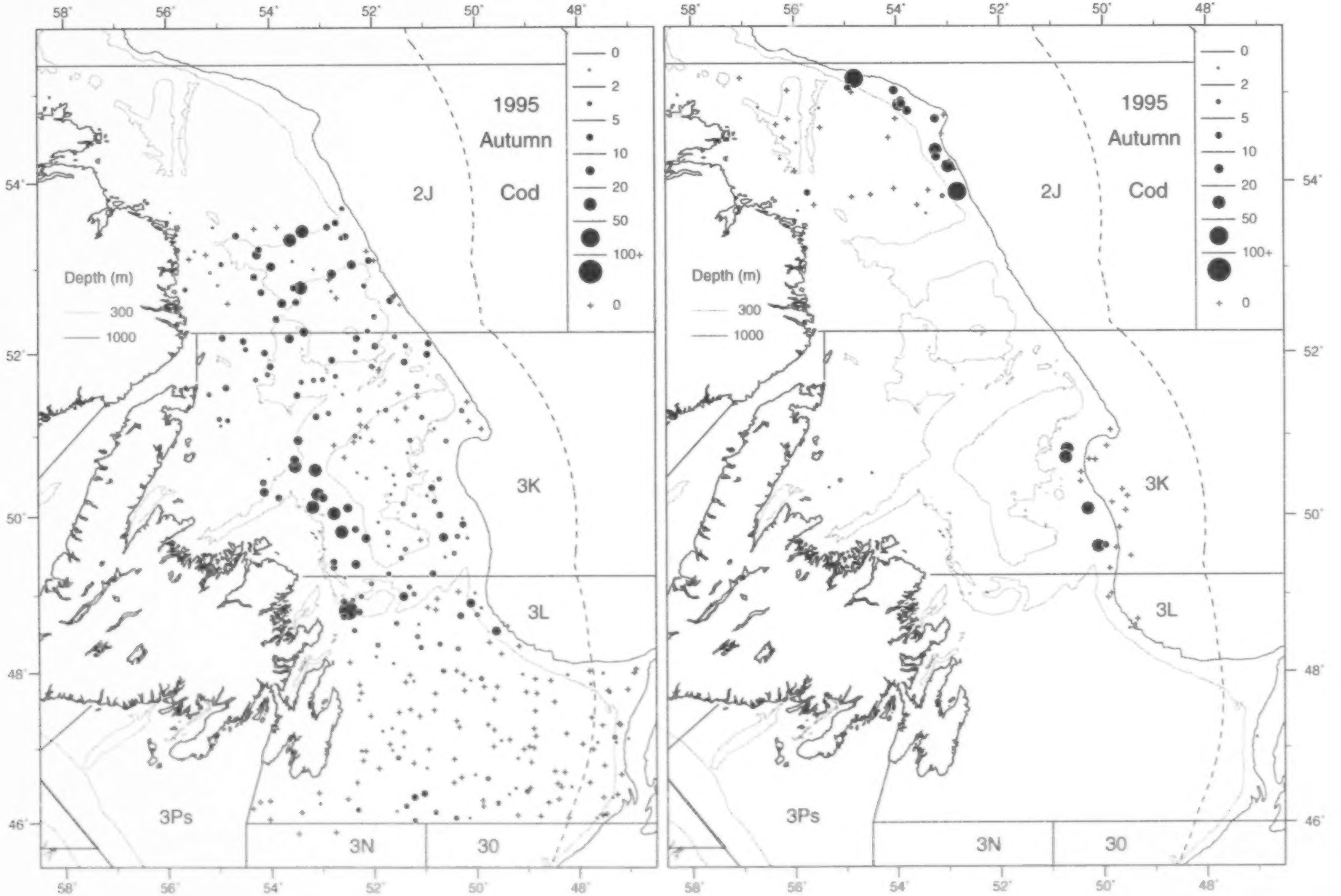

58°
56°
54°
52°
50°
48°
46°
1995
Autumn
Cod
2J
3K
3L
3Ps
3N
3O
Depth (m)
300
1000
0
2
5
10
20
50
100+
+ 0

Fig. 18a. Cod distribution (number per standard tow) during the autumn survey in divisions 2J3KL in 1995, showing those stations occupied during 1995 (left panel) and those occupied during 1996 (right panel).

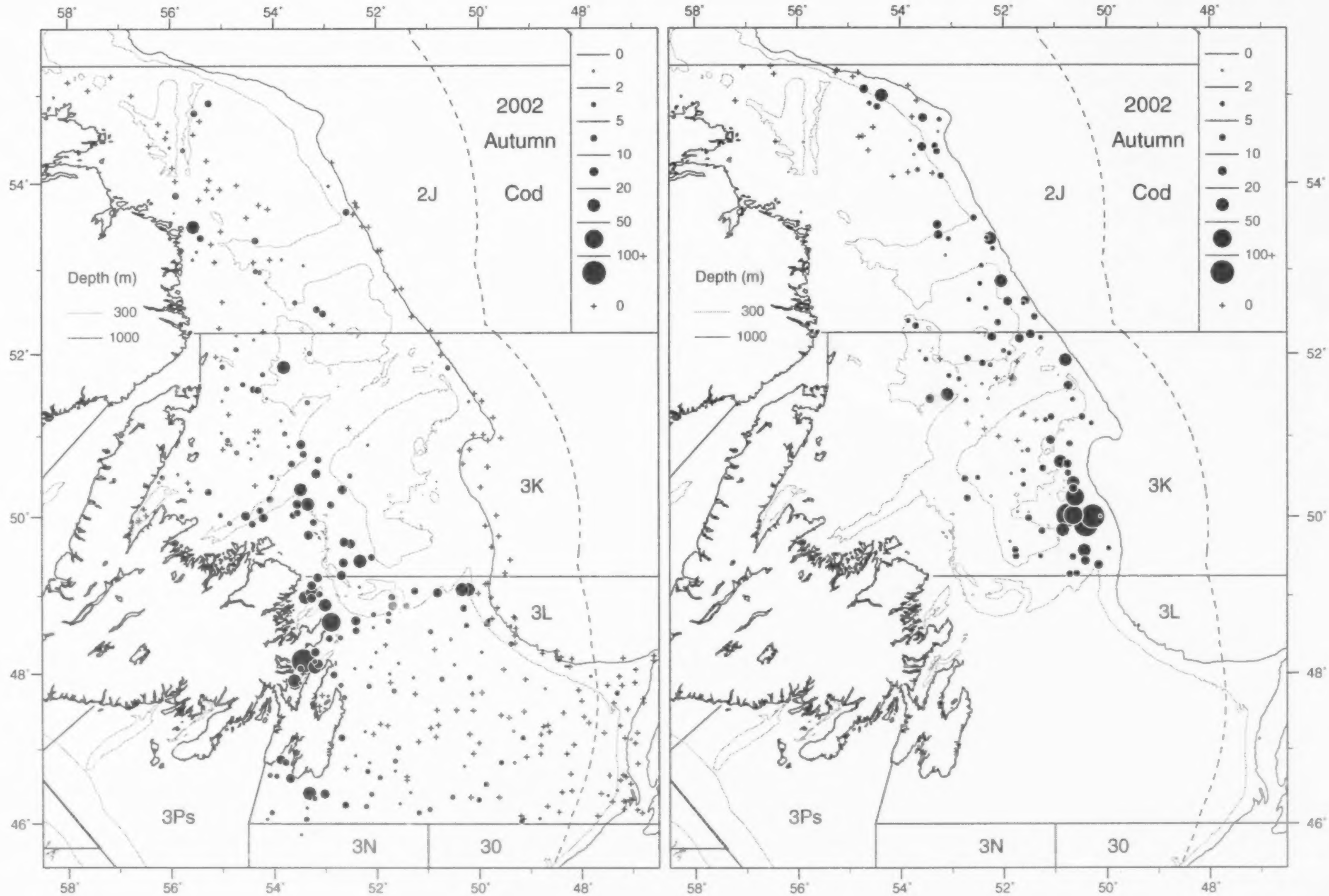

58°
56°
54°
52°
50°
48°
2002
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
54°
52°
50°
48°
46°

Fig. 18b. Cod distribution (number per standard tow) during the autumn survey in divisions 2J3KL in 2002, showing those stations occupied during 2002 (left panel) and those occupied during 2003 (right panel).

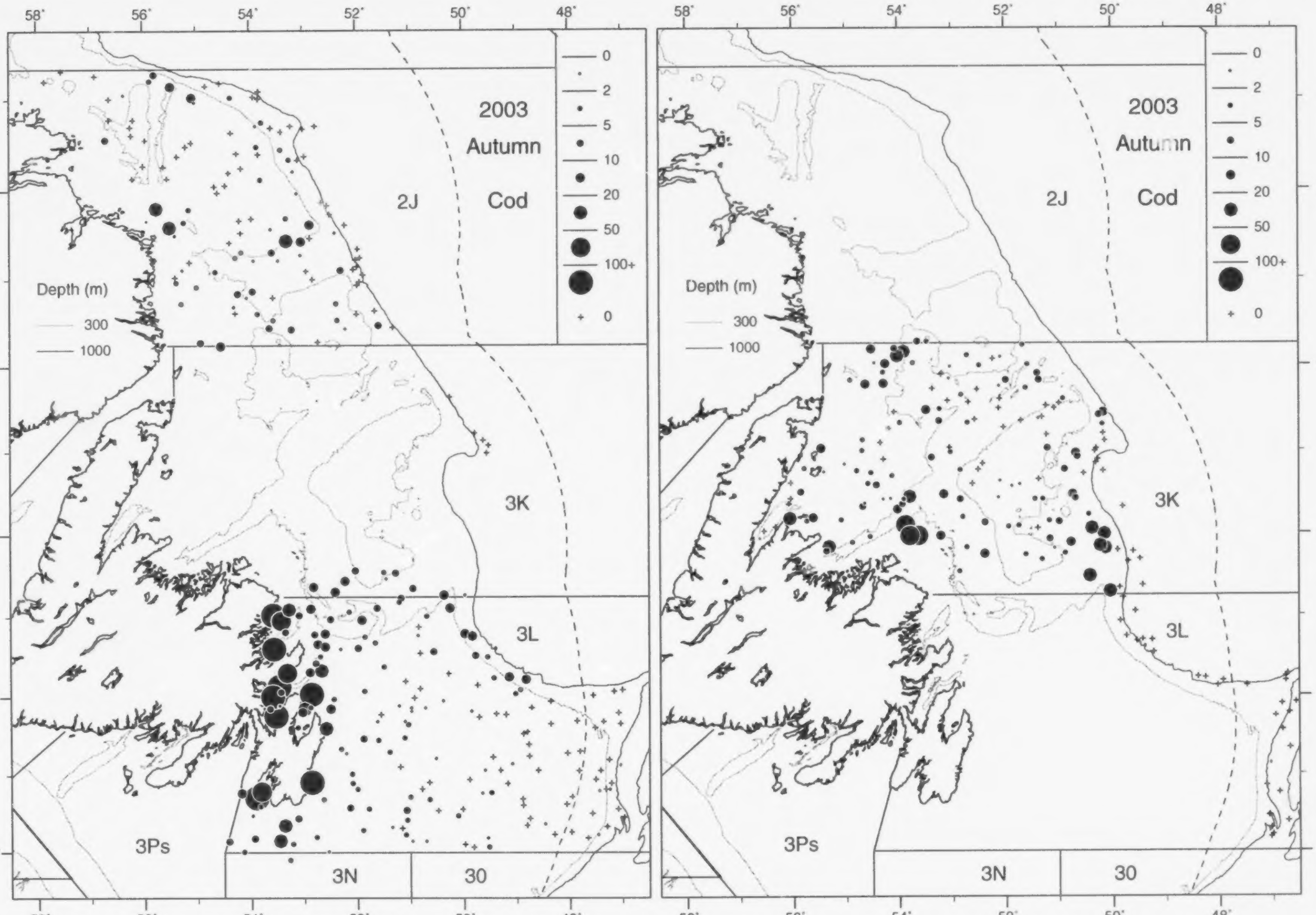

58˚
56˚
54˚
52˚
50˚
48˚
2003
Autumn
Cod
2J
3K
3L
3Ps
3N
30
Depth (m)
300
1000
0
2
5
10
20
50
100+
0
54˚
52˚
50˚
48˚
46˚

Fig. 18c. Cod distribution (number per standard tow) during the autumn survey in divisions 2J3KL in 2003, showing those stations occupied during 2003 (left panel) and those occupied during 2004 (right panel).

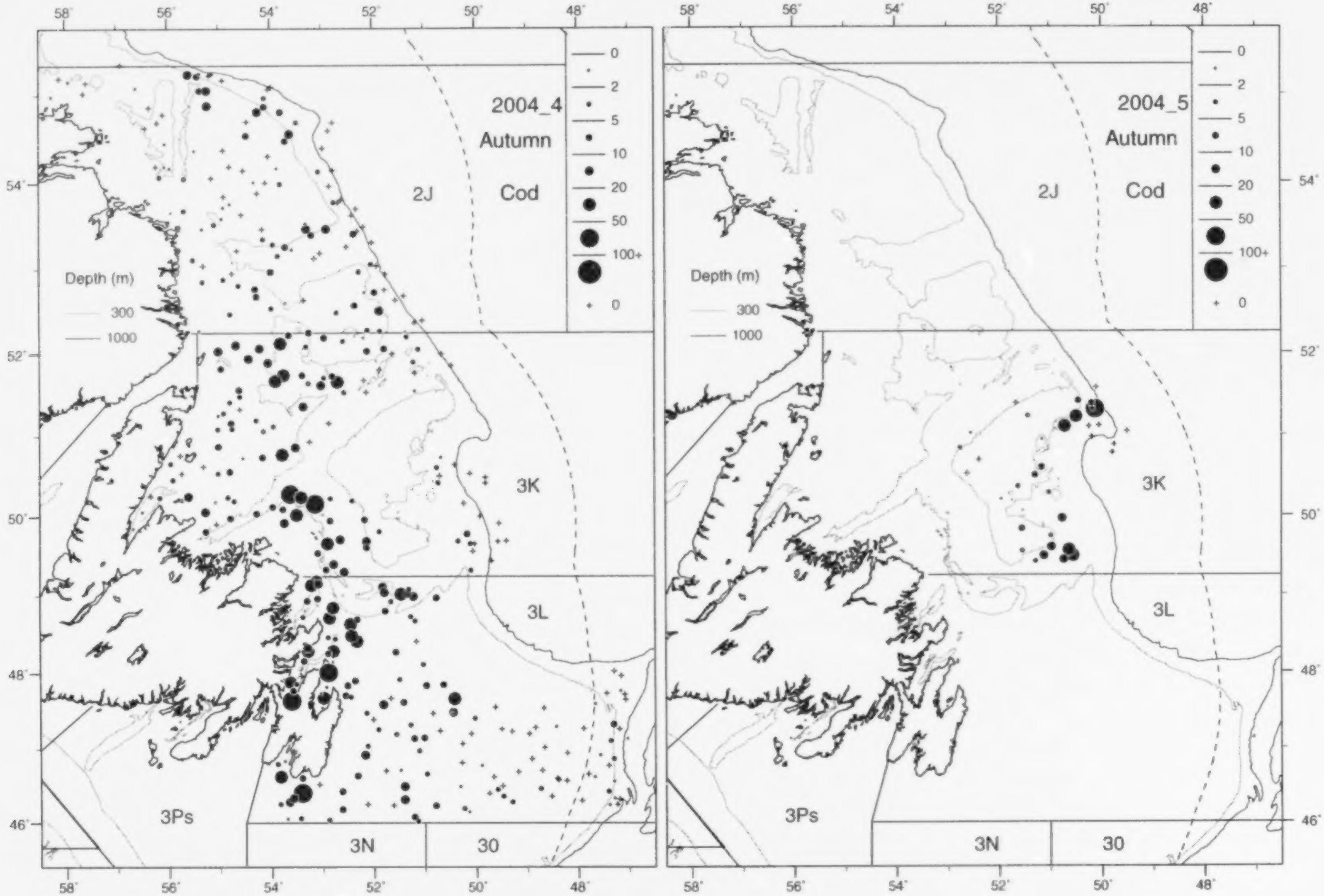

2004_4
Autumn
Cod
2004_5
Autumn
Cod
0
2
5
10
20
50
100+
0
Depth (m)
300
1000
2J
3K
3L
3Ps
3N
30
58°
56°
54°
52°
50°
48°
46°

Fig. 18d. Cod distribution (number per standard tow) during the autumn survey in divisions 2J3KL in 2004, showing those stations occupied during 2004 (left panel) and those occupied during 2005 (right panel).

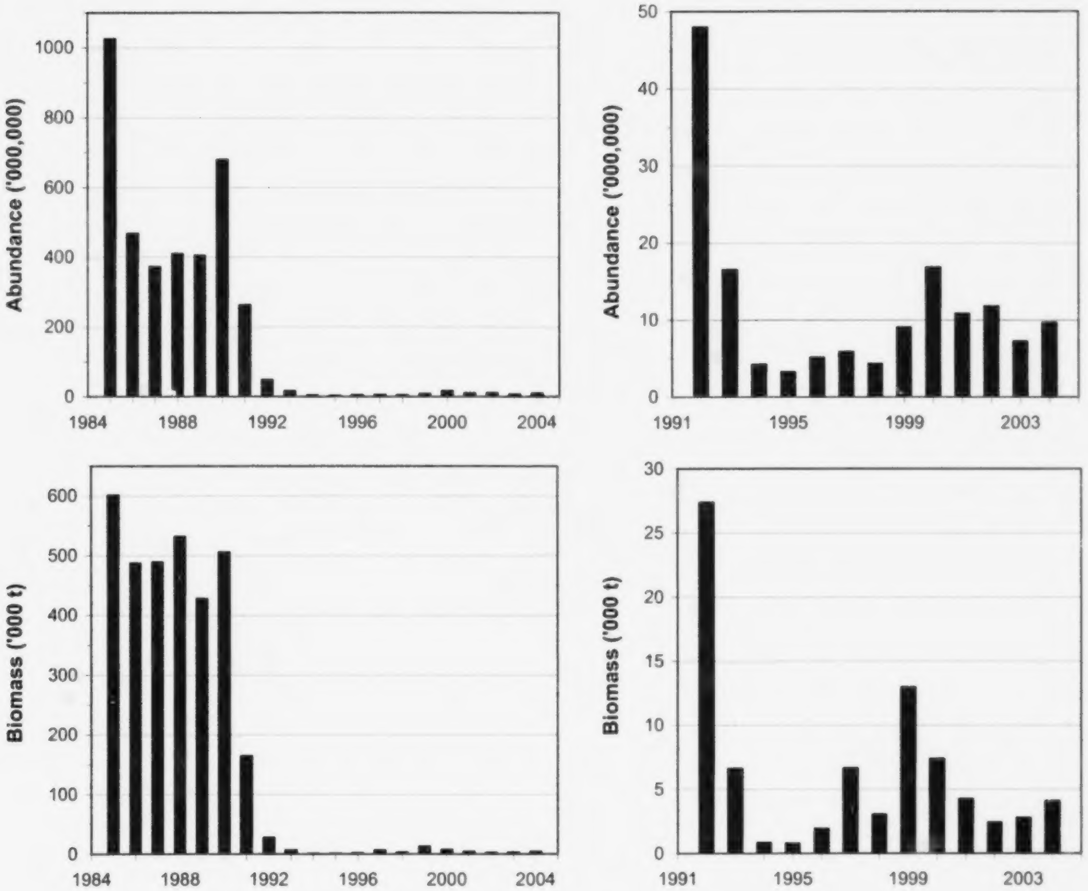


Fig. 19. Indices of abundance (above) and biomass (below) from spring bottom-trawl surveys in Division 3L. The left panels illustrate all estimates from 1985 to 2004. The right panels illustrate just the lower 5% of the left panels, in order that the 1992-2004 data may be more readily discerned.

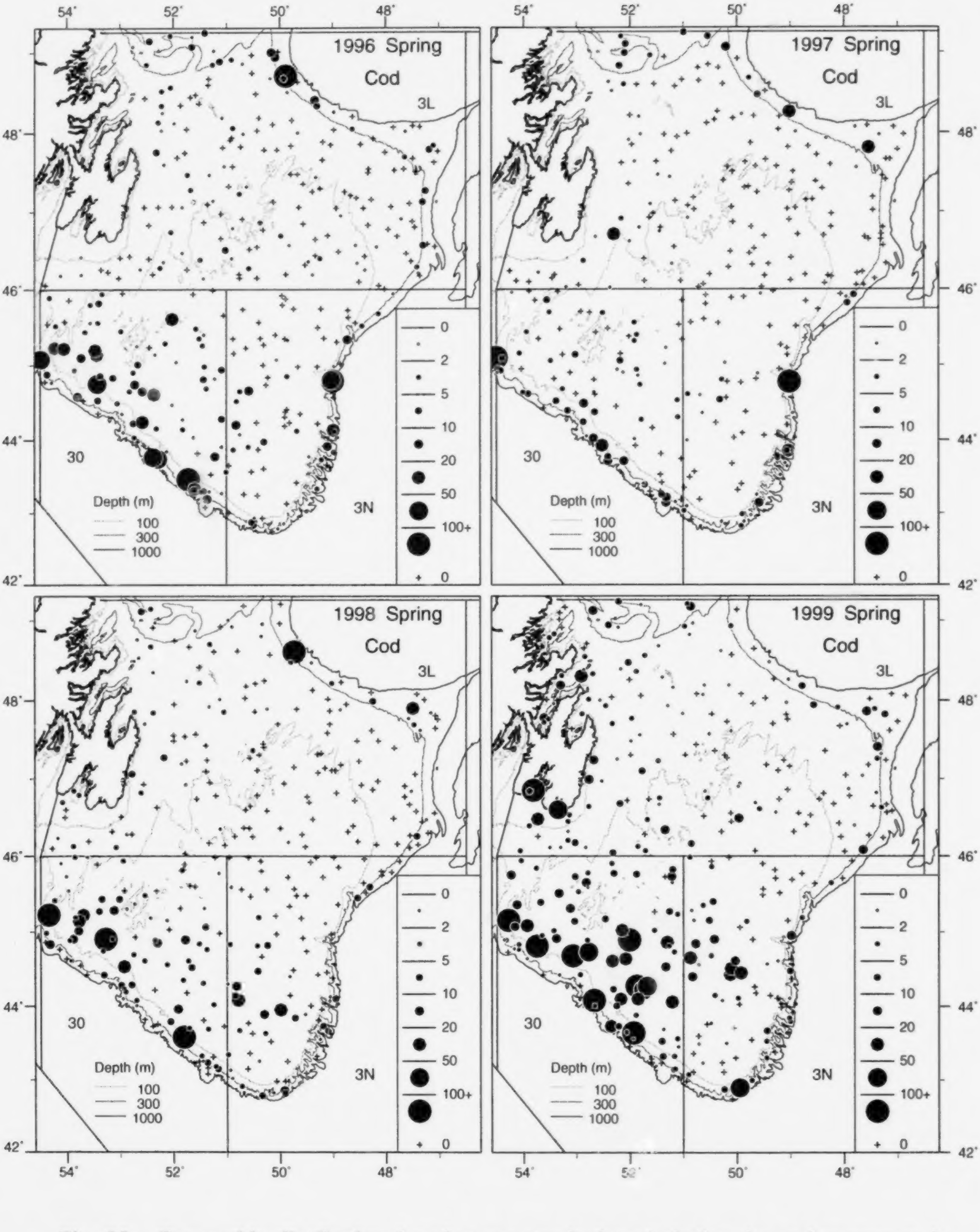
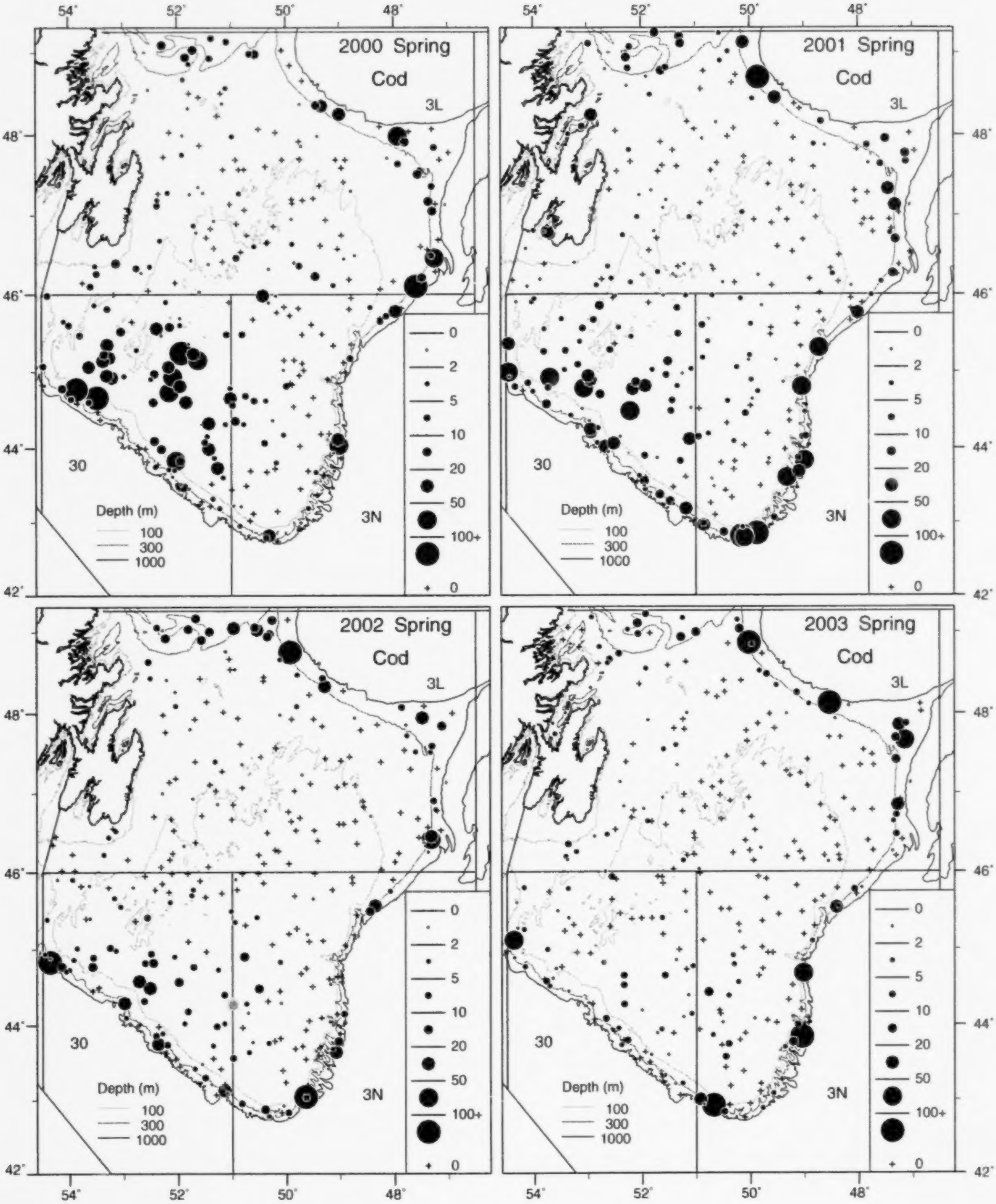
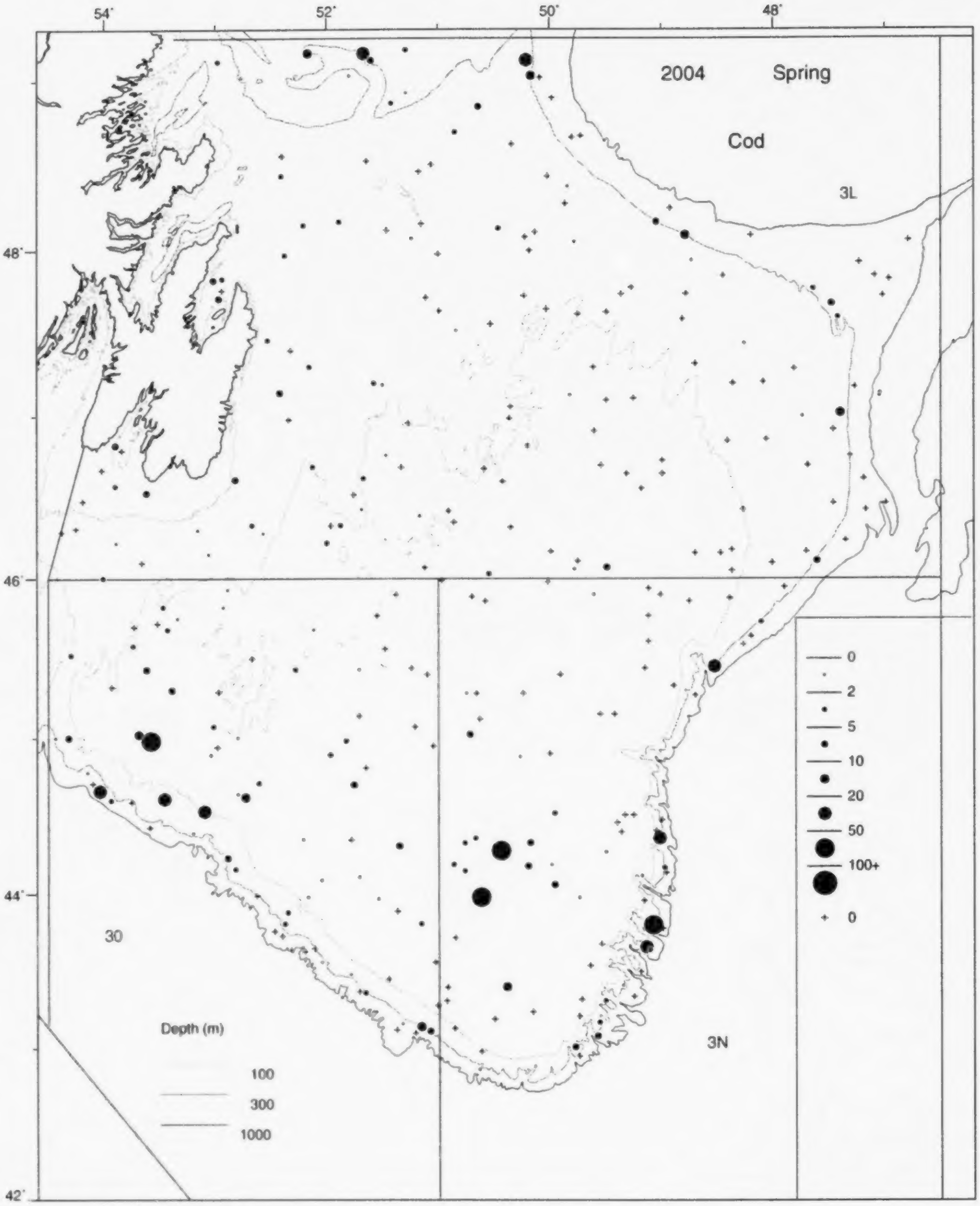

1996 Spring
Cod
1997 Spring
Cod
1998 Spring
Cod
1999 Spring
Cod
3L
3N
30
Depth (m)
100
300
1000
0
2
5
10
20
50
100+
+ 0
54°
52°
50°
48°
48°
46°
44°
42°

Fig. 20a. Geographic distribution (number per standard tow) during the spring surveys in divisions 3LNO in 1996-1999.



54°
52°
50°
48°
2000 Spring
Cod
3L
48°
46°
44°
42°
30
3N
Depth (m)
100
300
1000
0
2
5
10
20
50
100+
0
2001 Spring
Cod
3L
30
3N
Depth (m)
100
300
1000
0
2
5
10
20
50
100+
0
2002 Spring
Cod
3L
30
3N
Depth (m)
100
300
1000
0
2
5
10
20
50
100+
0
2003 Spring
Cod
3L
30
3N
Depth (m)
100
300
1000
0
2
5
10
20
50
100+
0

Fig. 20b. Geographic distribution (number per standard tow) during the spring surveys in divisions 3LNO in 2000-2003.



54°
52°
50°
48°
48°
46°
44°
42°
2004 Spring
Cod
3L
3O
3N
0
2
5
10
20
50
100+
0
Depth (m)
100
300
1000

Fig. 21. Geographic distribution (number per standard tow) during the spring survey in divisions 3LNO in 2004.

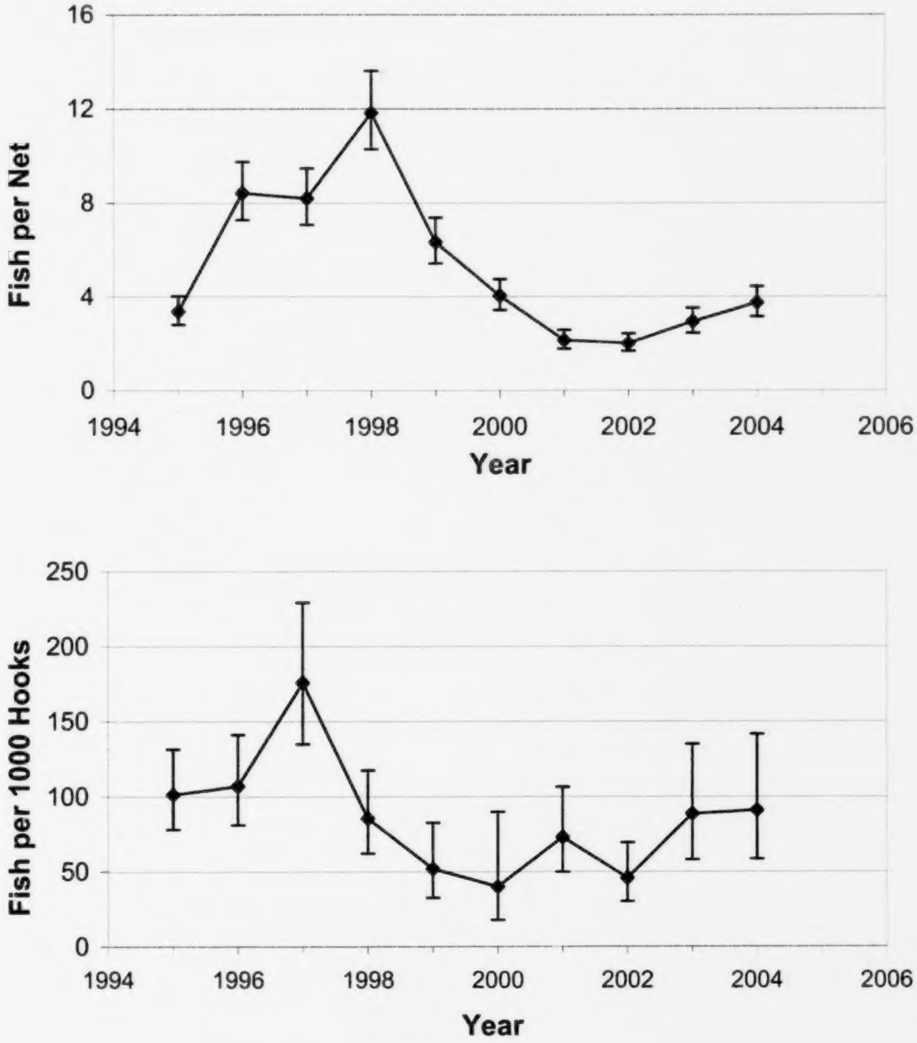


Fig. 22. Standardized catch rates from sentinel surveys in 2J3KL combined; gillnets (5½ inch mesh) above and linetrawls below.

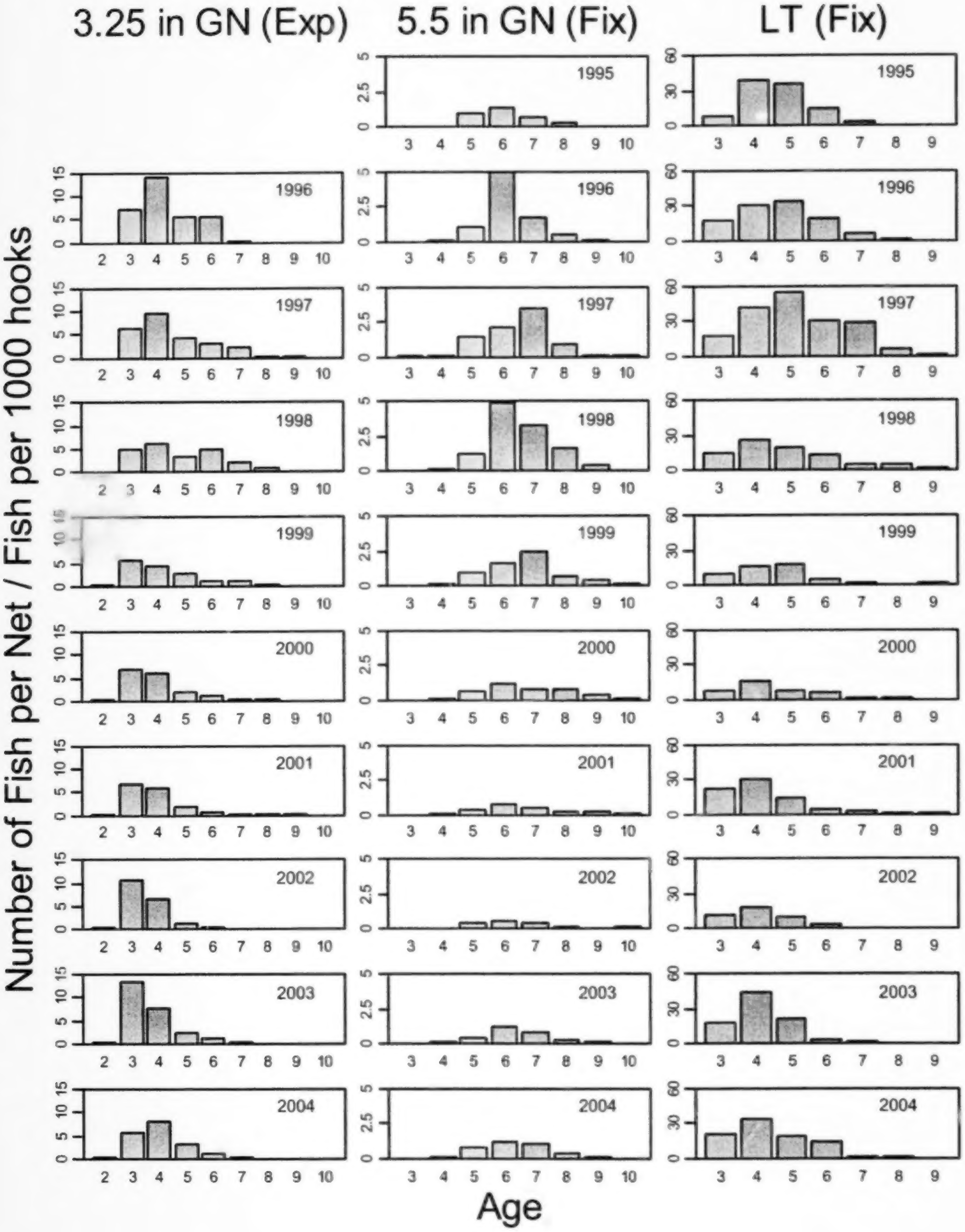


Fig. 23. Standardized catch rate at age for three gear types fished by the sentinel surveys in 1995-2004.

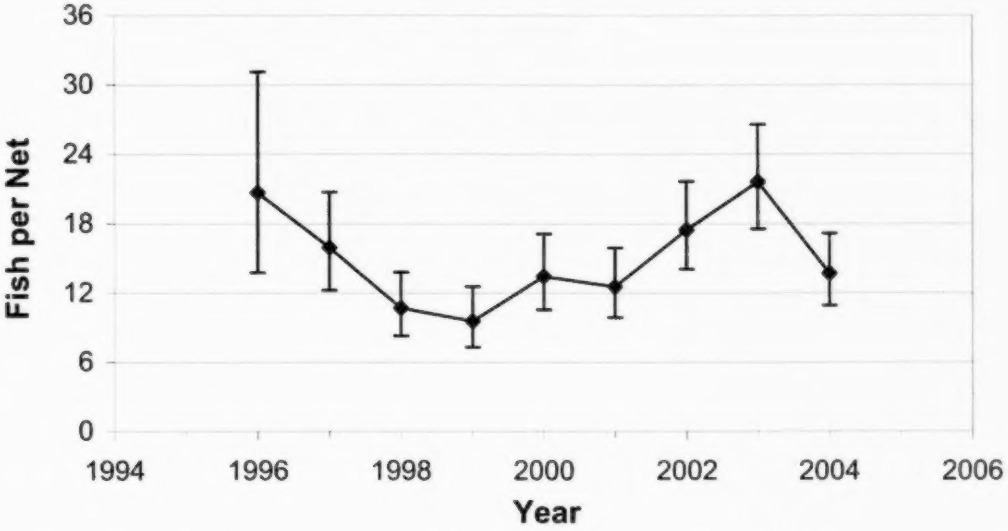


Fig. 24. Standardized catch rates at ages 3 and 4 combined from 3¼ inch sentinel gillnet surveys in 2J3KL combined.

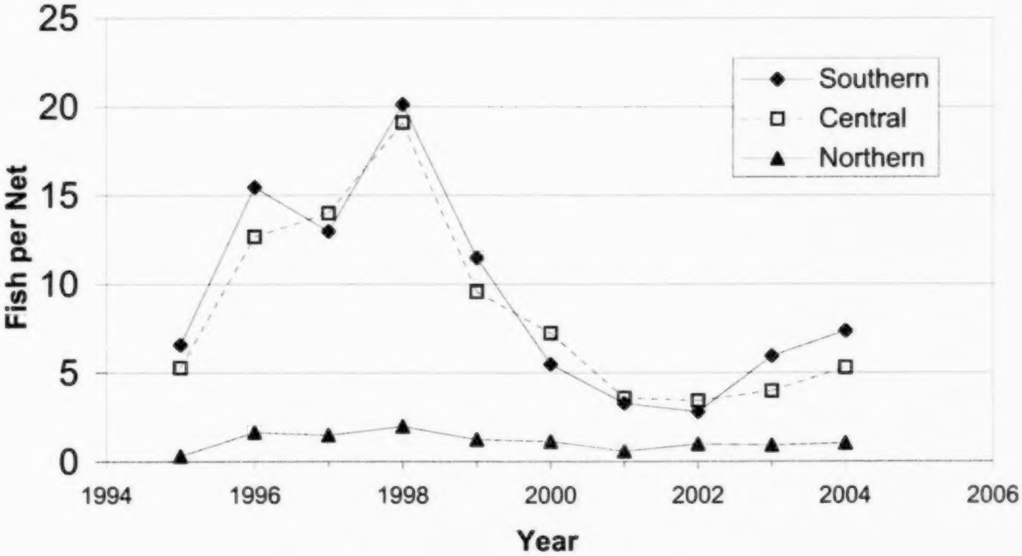


Fig. 25. Standardized catch rates from sentinel 5½ inch gillnet surveys in the northern, central and southern areas of the inshore as defined during this assessment (Fig. 1h).

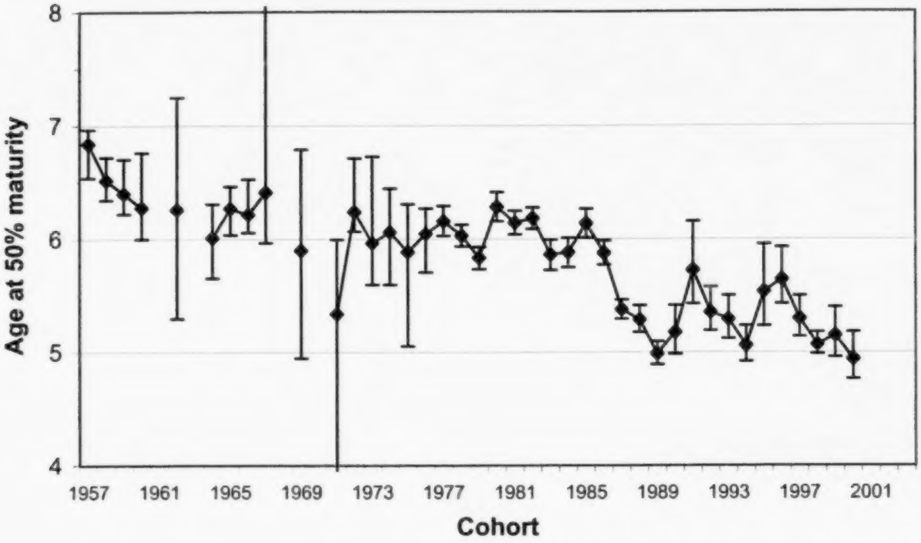


Fig. 26. Age at 50% maturity (± 95% CI) by cohort for female cod in divisions 2J3KL combined based on sampling during autumn research bottom-trawl surveys.

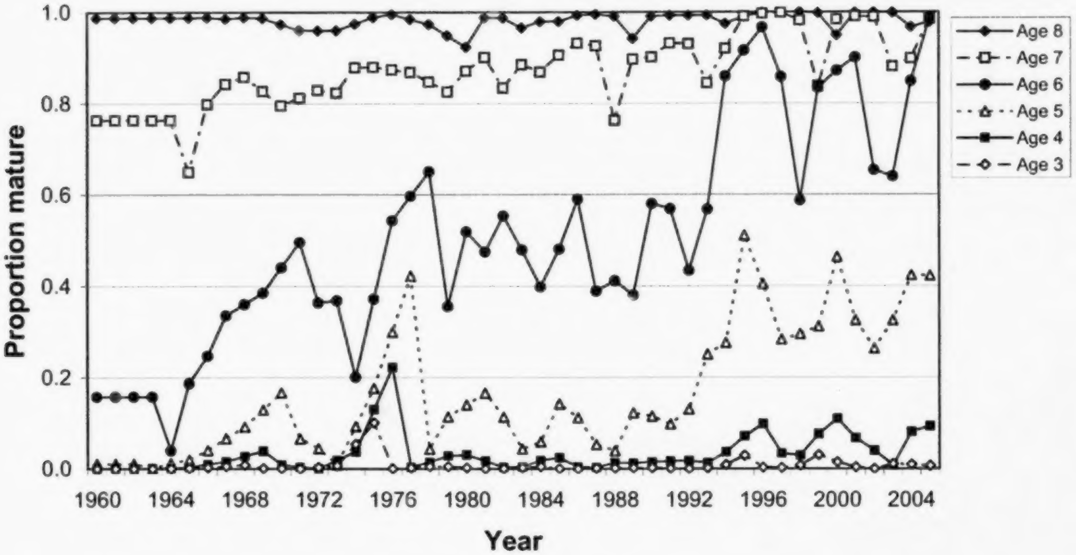


Fig. 27. Estimated percentage mature at ages 3-8 for female cod in divisions 2J3KL combined. The percentage mature at age estimated from sampling during the autumn research bottom-trawl survey in year t is displayed for spawning in year t+1.

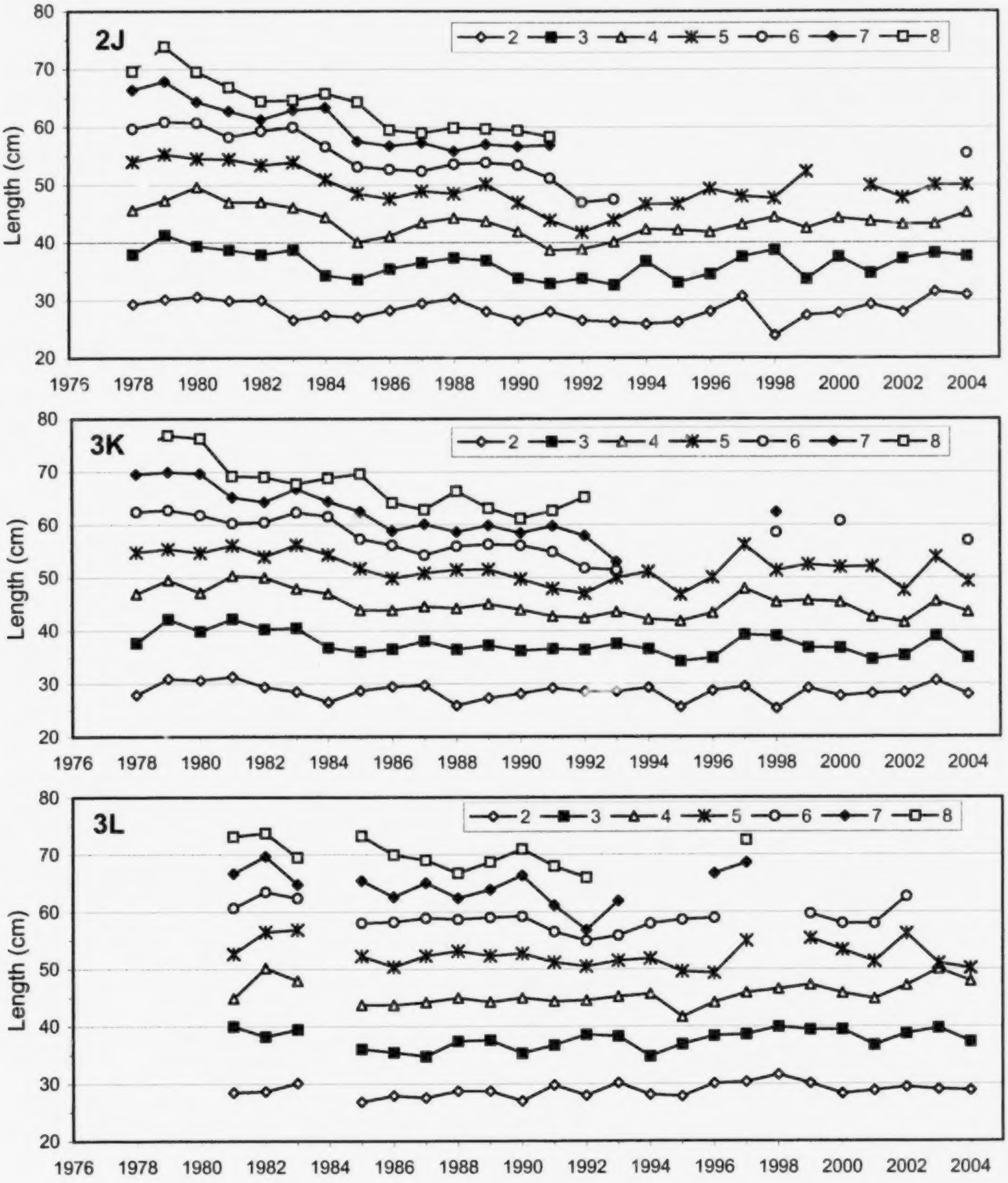


Fig. 28. Mean lengths at ages 2-8 of cod in Divisions 2J, 3K and 3L in 1978-2004, as determined from sampling during bottom-trawl surveys in autumn. Values calculated from fewer than 5 aged fish are not plotted. There were no surveys in Division 3L in 1978-1980 and 1984.

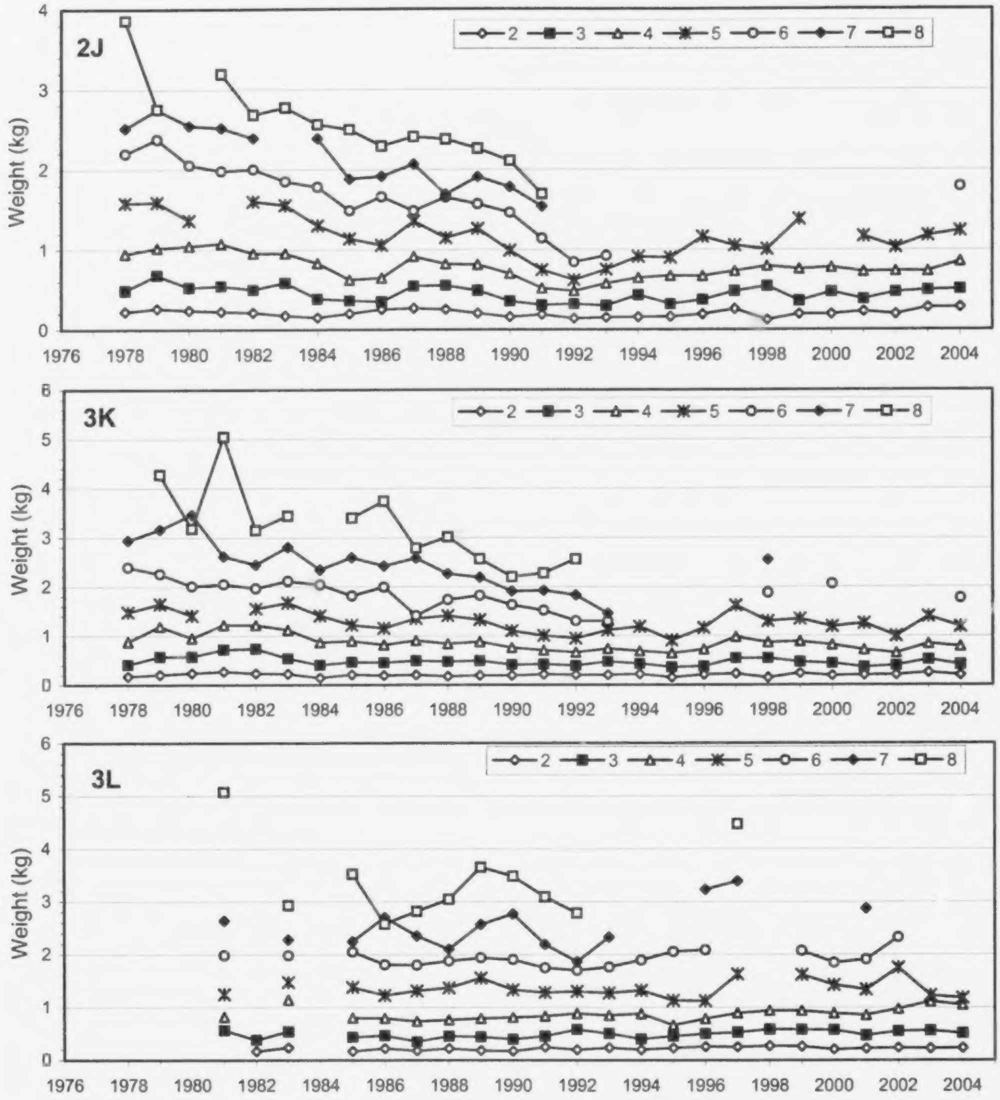


Fig. 29. Mean weights at ages 2-8 of cod in Divisions 2J, 3K and 3L in 1978-2004, as determined from sampling during bottom-trawl surveys in autumn. Values calculated from fewer than 5 aged fish are not plotted. There were no surveys in Division 3L in 1978-1980 and 1984.

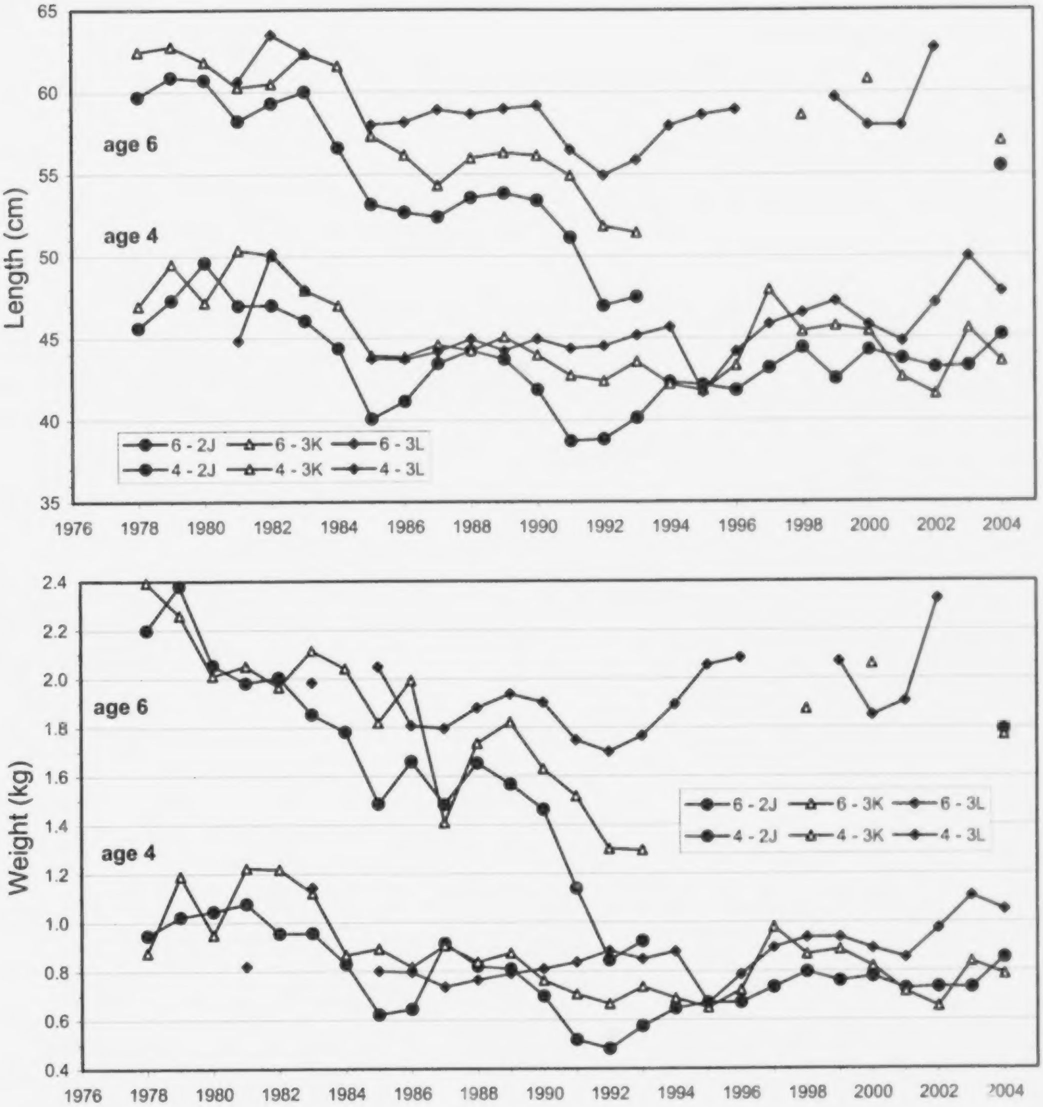


Fig. 30. Mean lengths and weights at ages 4 and 6 of cod in Divisions 2J, 3K and 3L in 1978-2004, as determined from sampling during bottom-trawl surveys in autumn. Values calculated from fewer than 5 aged fish are not plotted. There were no surveys in Division 3L in 1978-1980 and 1984.

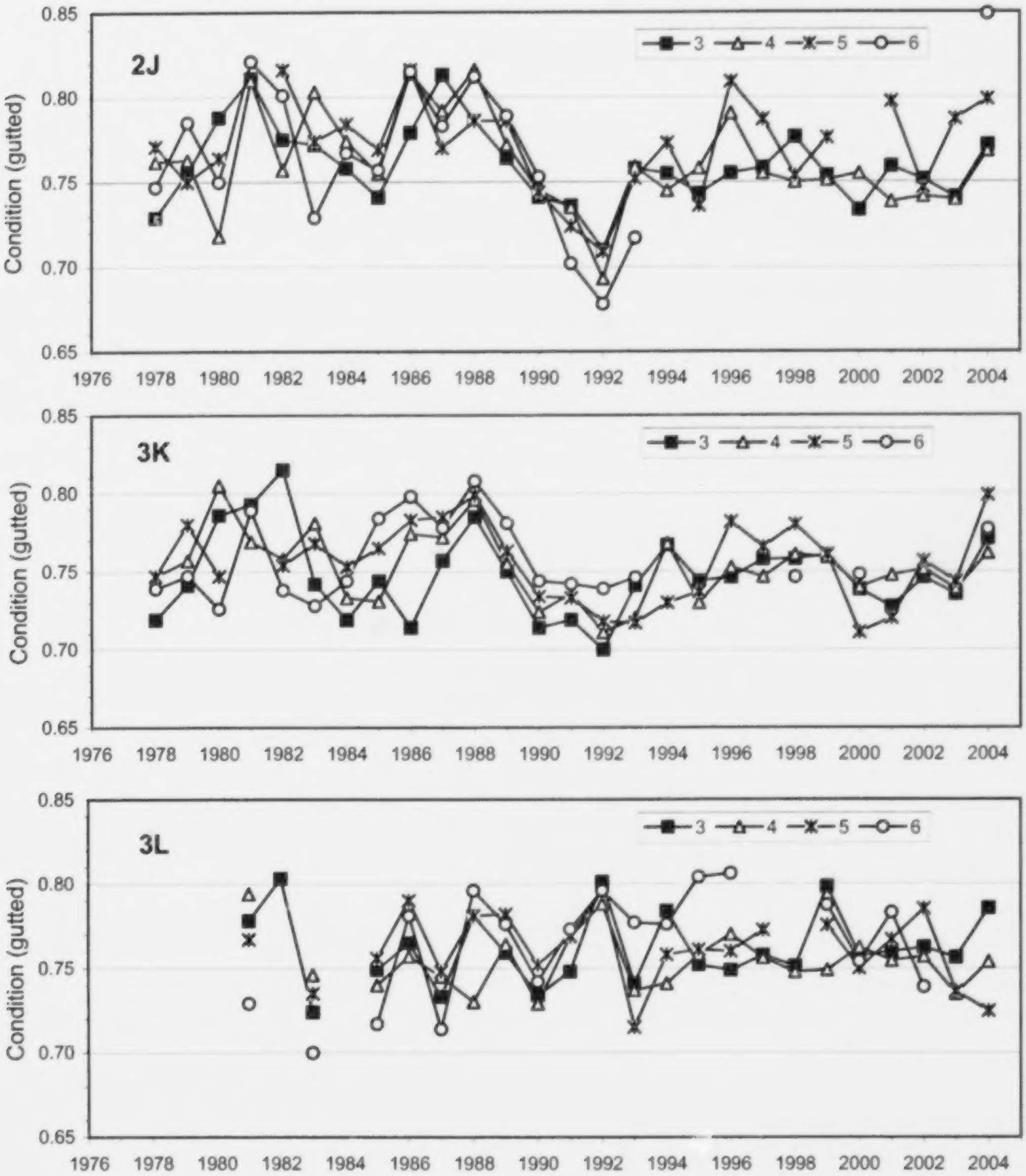


Fig. 31. Mean Fulton's condition (gutted weight) at ages 3-6 of cod in Divisions 2J, 3K and 3L in 1978-2004, as determined from sampling during bottom-trawl surveys in autumn. Values calculated from fewer than 5 aged fish are not plotted. There were no surveys in Division 3L in 1978-1980 and 1984.

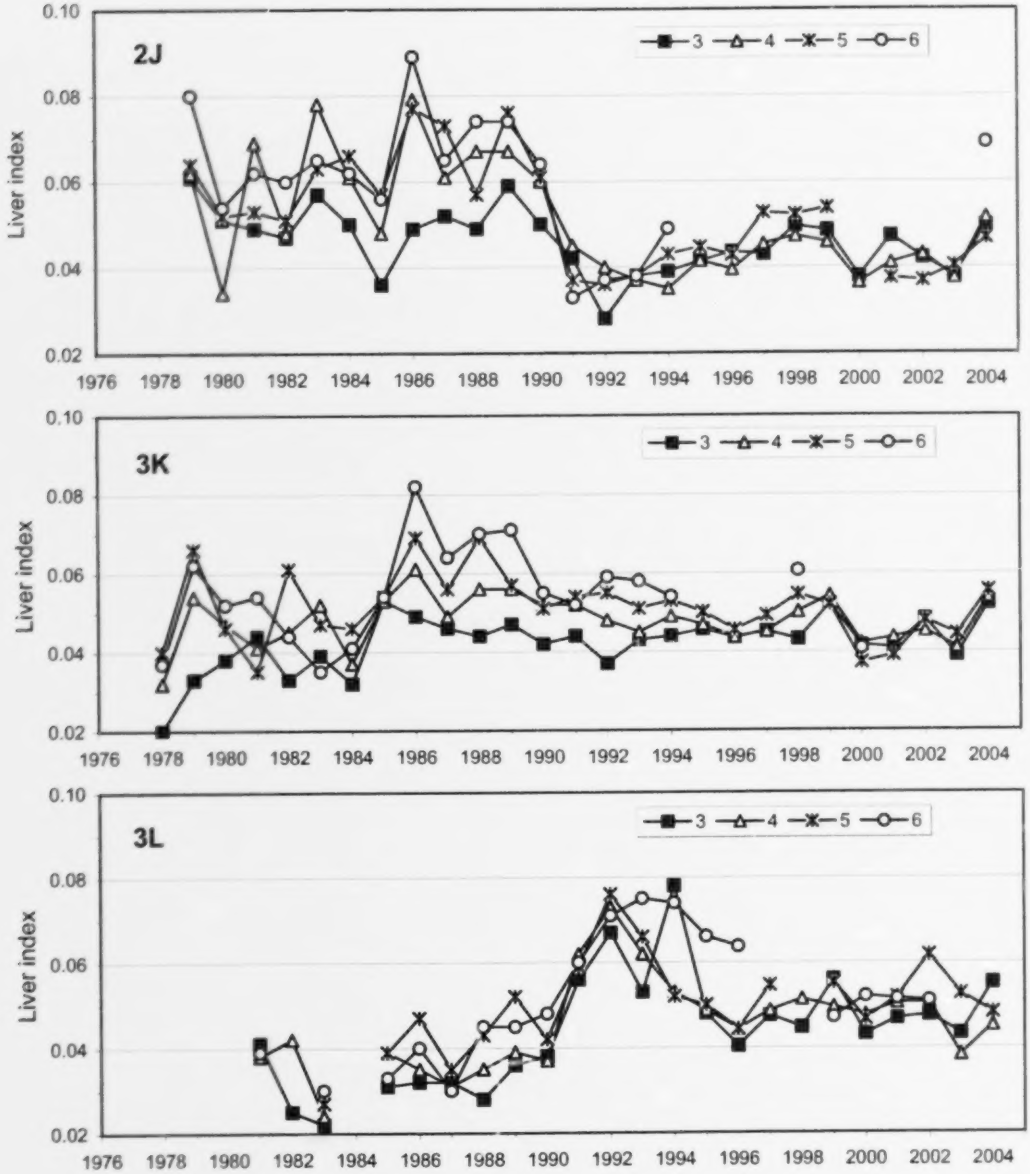


Fig. 32. Mean liver index at ages 3-6 of cod in Divisions 2J, 3K and 3L in 1978-2004, as determined from sampling during bottom-trawl surveys in autumn. Values calculated from fewer than 5 aged fish in 1995-1997 are not plotted. There were no surveys in Division 3L in 1978-1980 and 1984.

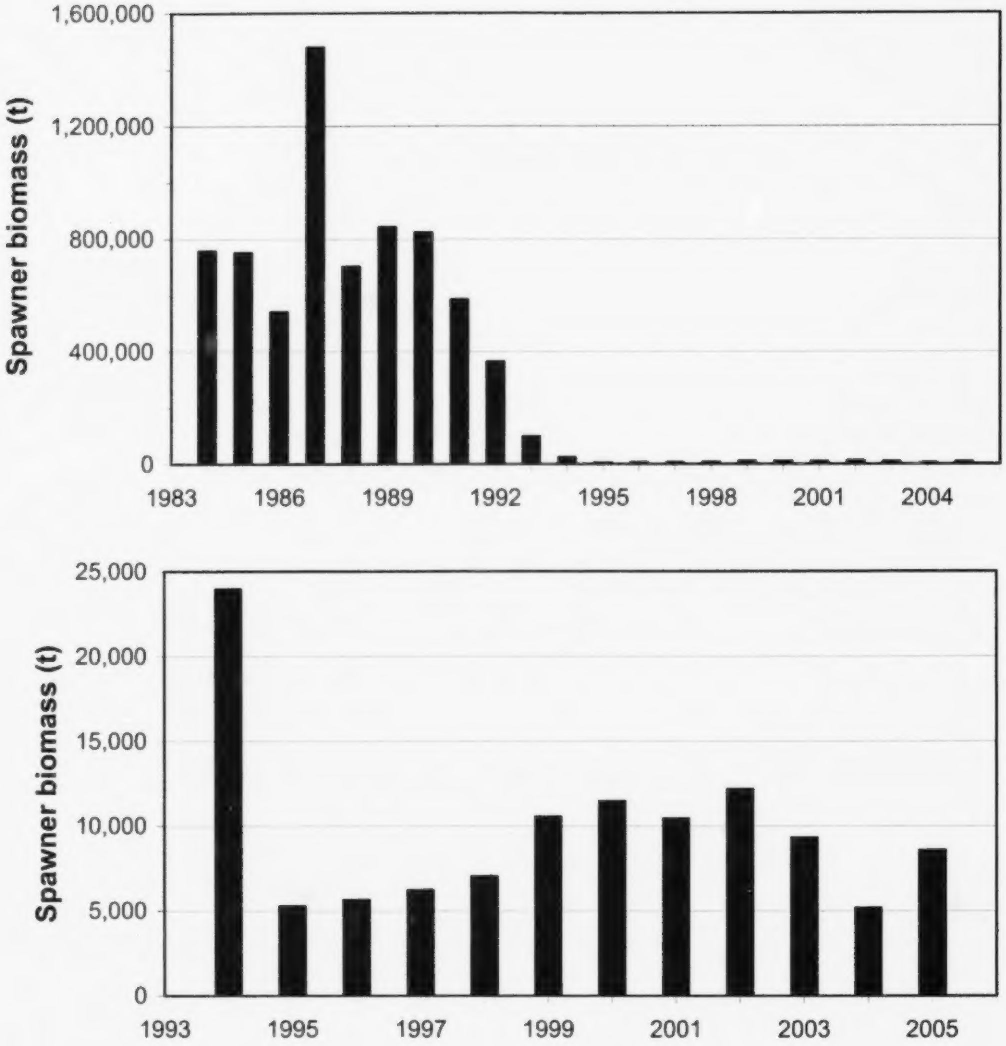


Fig. 33. Trend in the index of spawner stock biomass (SSB) in the offshore of 2J3KL, computed from population estimates at age (from areal expansion of the stratified arithmetic mean catch at age per tow during autumn bottom-trawl surveys), the proportion mature at age, and the Jan. 1 weight at age computed from commercial weights at age. The catch in autumn of year t has been used to compute biomass on Jan. 1 of year t+1. (This is why the strong positive anomaly appears in 1987 instead of in 1986.) Note that the survey trawl was changed in 1995, and data collected prior to 1995 have been converted so as to be equivalent to data collected from 1995 onward.

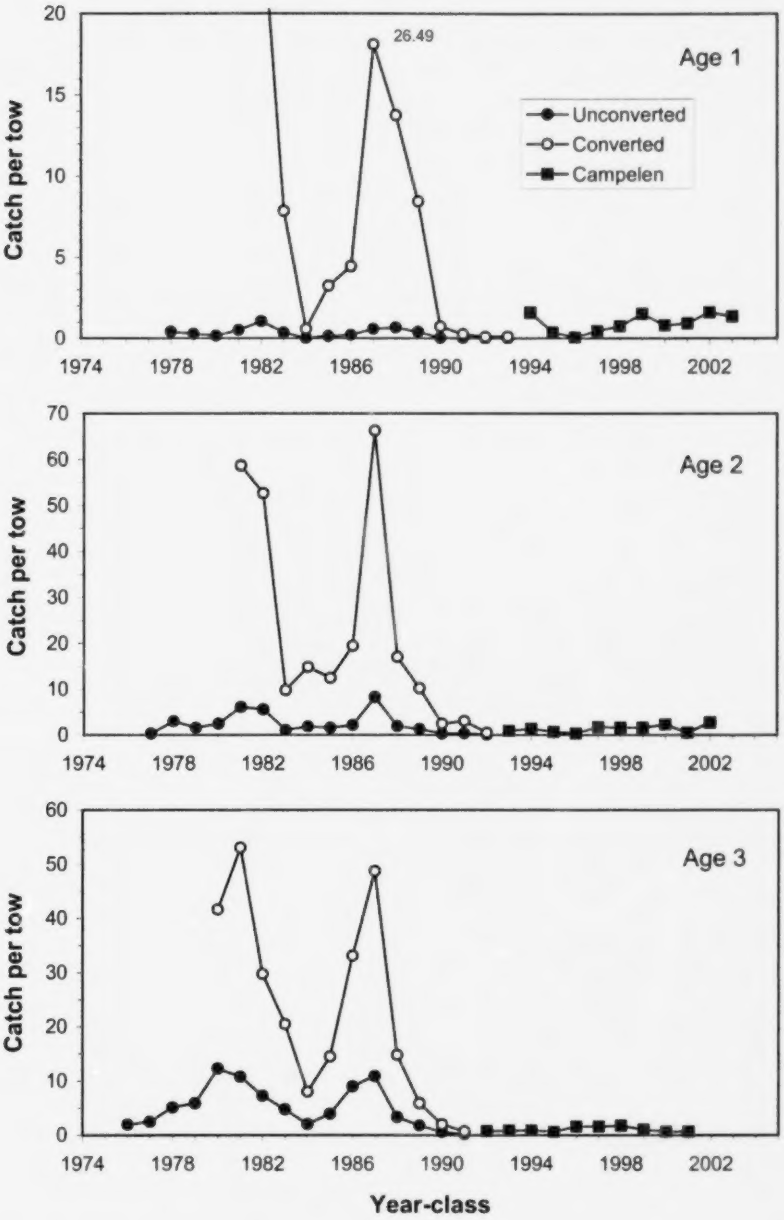


Fig. 34. Mean catch per tow of the 1976-2003 year-classes at ages 1-3 during autumn bottom-trawl surveys in divisions 2J, 3K and 3L combined. Data obtained prior to the introduction of the Campelen trawl in 1995 are shown as actual (unconverted) numbers (from Shelton et al. 1996) and in numbers converted to Campelen equivalents.

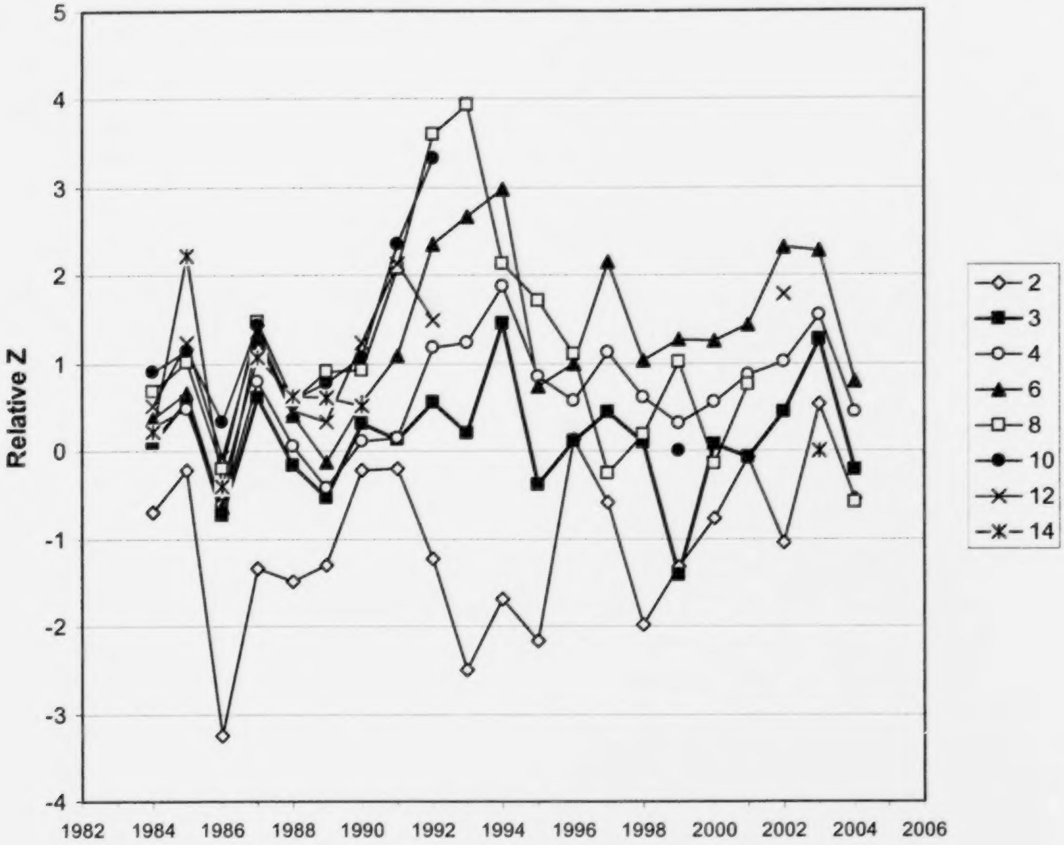


Fig. 35. Instanteous total mortality rates (Z) experienced by fish aged 2 to 15 (only selected ages illustrated) as calculated from catch rate at age per tow during the autumn research bottom-trawl surveys in 2J3KL combined in 1983-2004. For example, the value of 2.16 for age 6 in 1997 is the mortality experienced by the 1991 year-class from age 5 in the autumn of 1996 to age 6 in the autumn of 1997.

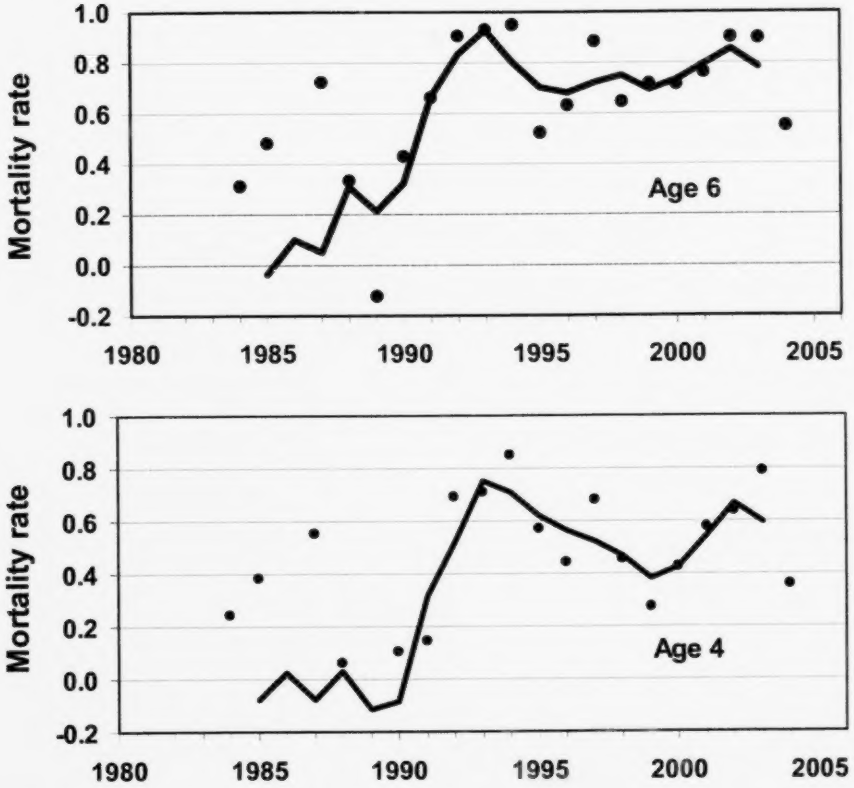


Fig. 36. Age specific annual mortality rate (proportion dying from one year to the next) calculated from mean catch at age per tow during the autumn bottom-trawl surveys in 2J3KL. As an example, in the age 4 panel, the value of 0.85 in 1994 is the mortality experienced by the 1990 year-class from age 3 in 1993 to age 4 in 1994. The line is a 3-year moving average. Data points less than –0.2, which occurred only before 1990, are not shown. Note that the high level of variability, especially prior to the stock collapse, is a reflection of the high among-year variability in the surveys. The most extreme instance was the anomalously high index value in 1986, which resulted in the appearance of production of fish (negative mortality) from 1985 to 1986 and the appearance of very high mortality from 1986 to 1987. Note as well that the rates should be interpreted as indicators of trends over time, rather than absolute values. Rates calculated for younger ages (e.g. from age 3 to age 4) may underestimate mortality for two reasons: the proportion of a year-class available to the survey increases with age as the fish move to the offshore from inshore nursery grounds, and the proportion of the available fish caught by the trawl increases with fish length. The latter phenomenon was especially true for the trawl that was used prior to 1995. Although the catch rates from that trawl have been adjusted to those of the new trawl with a length-based conversion formula, the success of the conversion may have declined with decreasing fish length because of an increase in the proportion of sets where fish were available but the catch was nil.

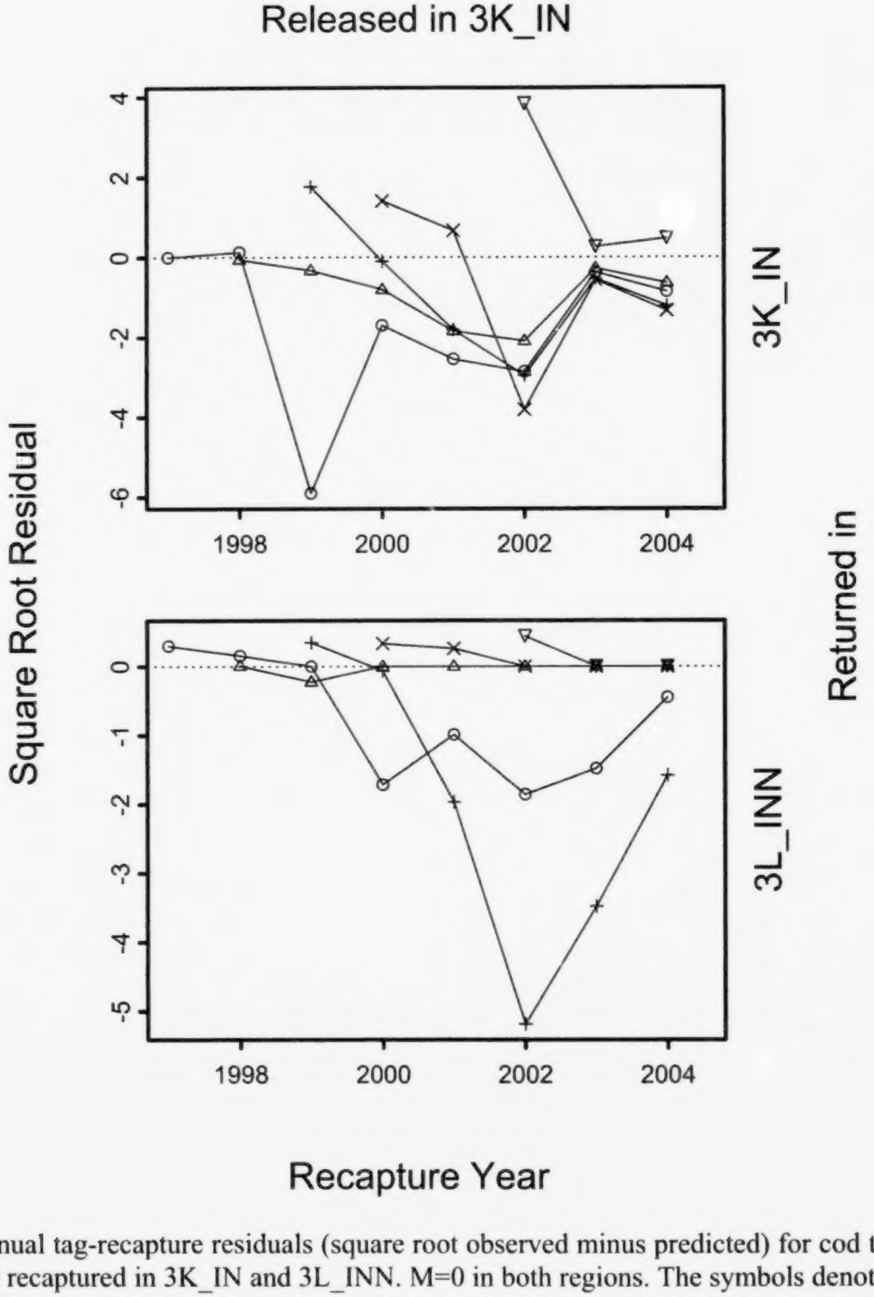


Fig. 37. Annual tag-recapture residuals (square root observed minus predicted) for cod tagged in 3K_IN, and recaptured in 3K_IN and 3L_INN. M=0 in both regions. The symbols denote release years: ○ 1997, △ 1998, + 1999, × 2000, ◇ 2001, ▽ 2002. Trends in 2003-04 are discounted because of the low numbers of returns in these years.

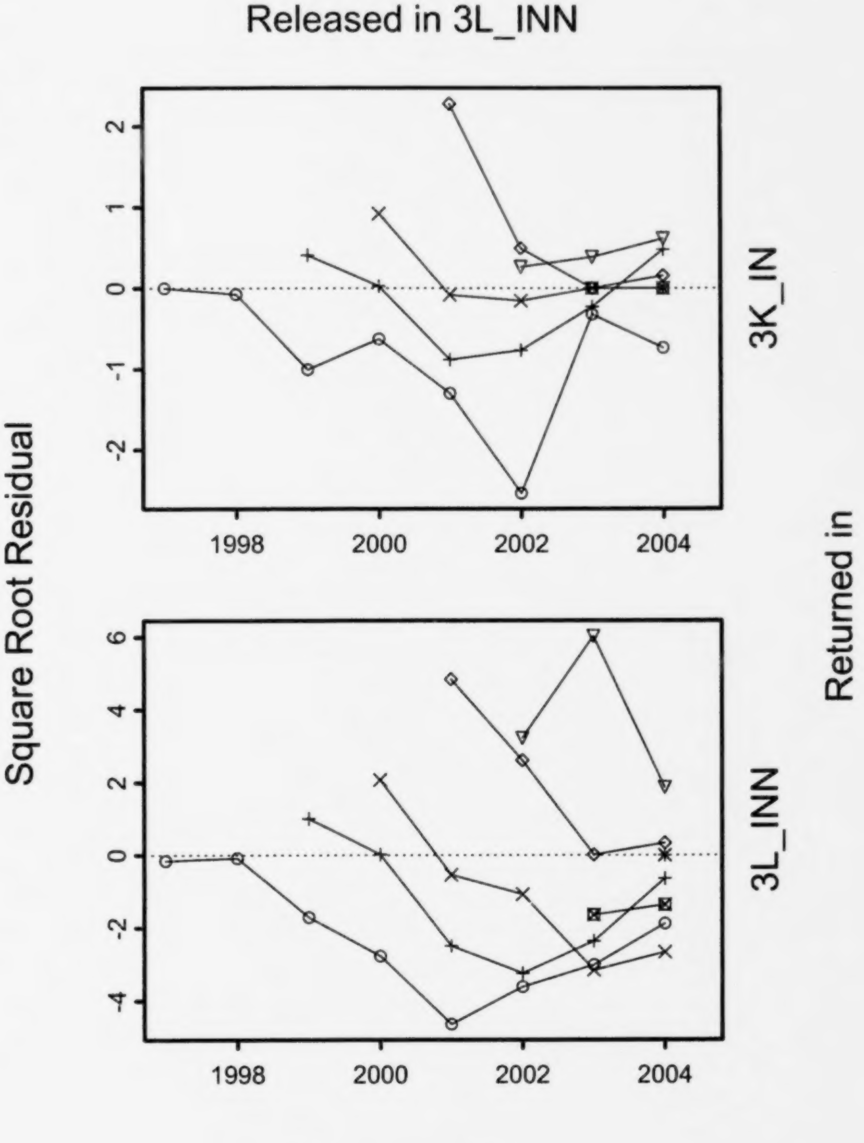


Fig. 38. Annual tag-recapture residuals (square root observed minus predicted) for cod tagged in 3L_INN, and recaptured in 3K_IN and 3L_INN. M=0 in both regions. The symbols denote release years: ○ 1997, △ 1998, + 1999, × 2000, ◇ 2001, ▽ 2002. Trends in 2003-04 are discounted because of the low numbers of returns in these years.

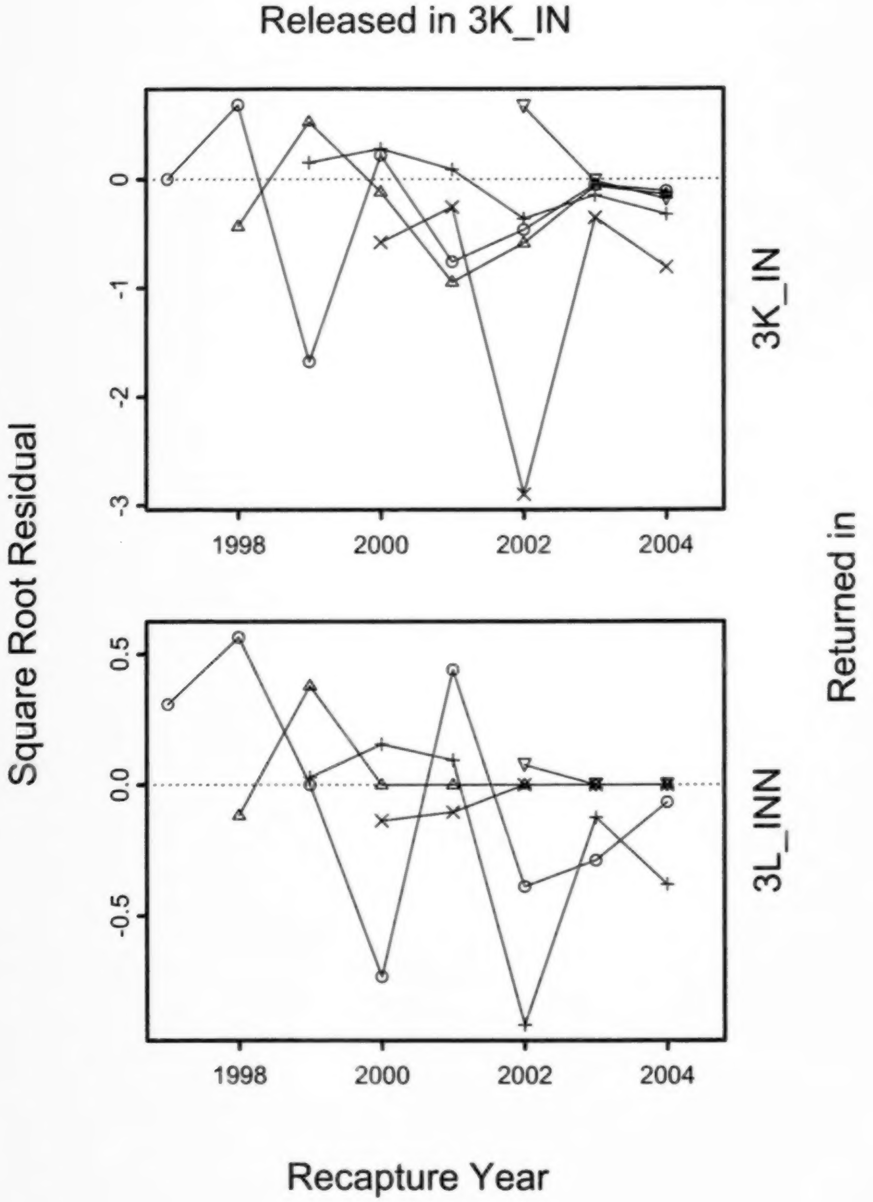


Fig. 39. Annual tag-recapture residuals (square root observed minus predicted) for cod tagged in 3K_IN, and recaptured in 3K_IN and 3L_INN. M=0.8 in 3K_INN and M=0.4 in 3L_INN. The symbols denote release years: ○ 1997, △ 1998, + 1999, × 2000, ◇ 2001, ▽ 2002. Trends in 2003-04 are discounted because of the low numbers of returns in these years.

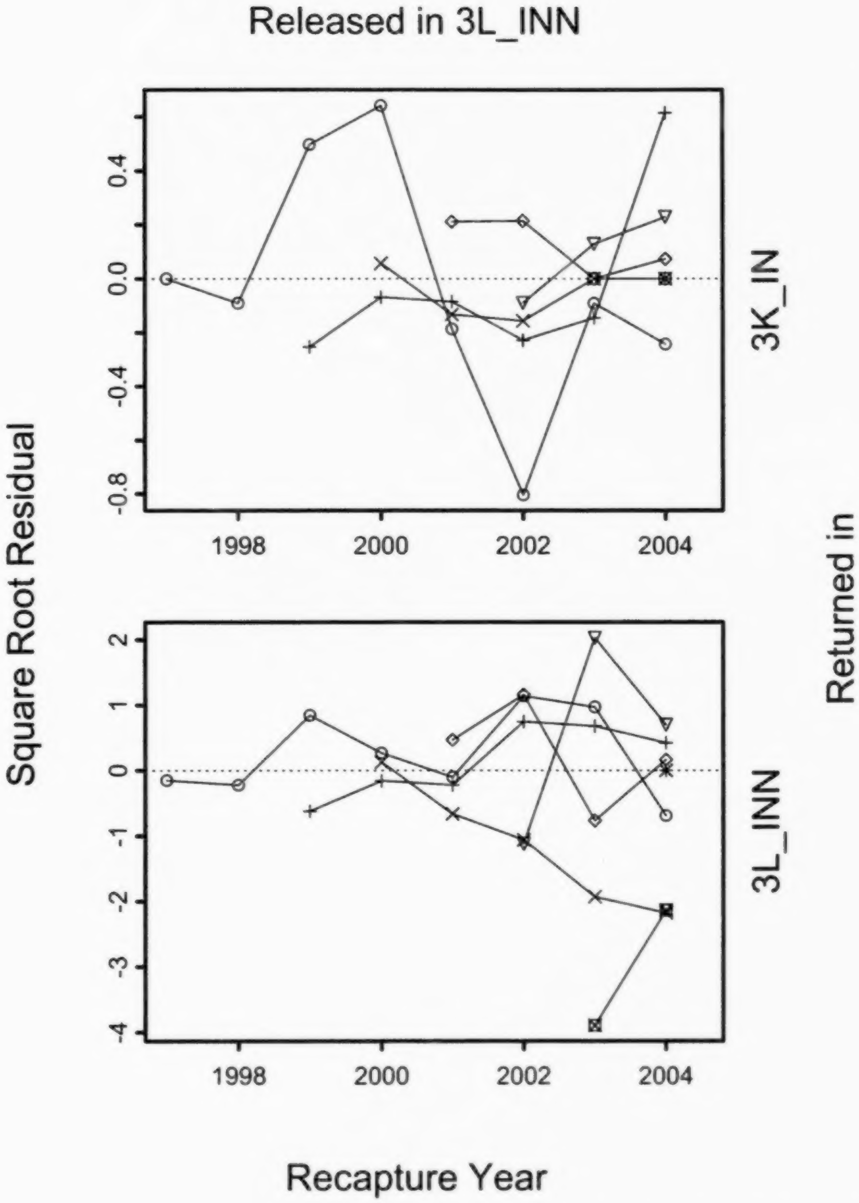


Fig. 40. Annual tag-recapture residuals (square root observed minus predicted) for cod tagged in 3L_INN, and recaptured in 3K_IN and 3L_INN. M=0.8 in 3K_INN and M=0.4 in 3L_INN. The symbols denote release years: ○ 1997, △ 1998, + 1999, × 2000, ◇ 2001, ▽ 2002. Trends in 2003-04 are discounted because of the low numbers of returns in these years.

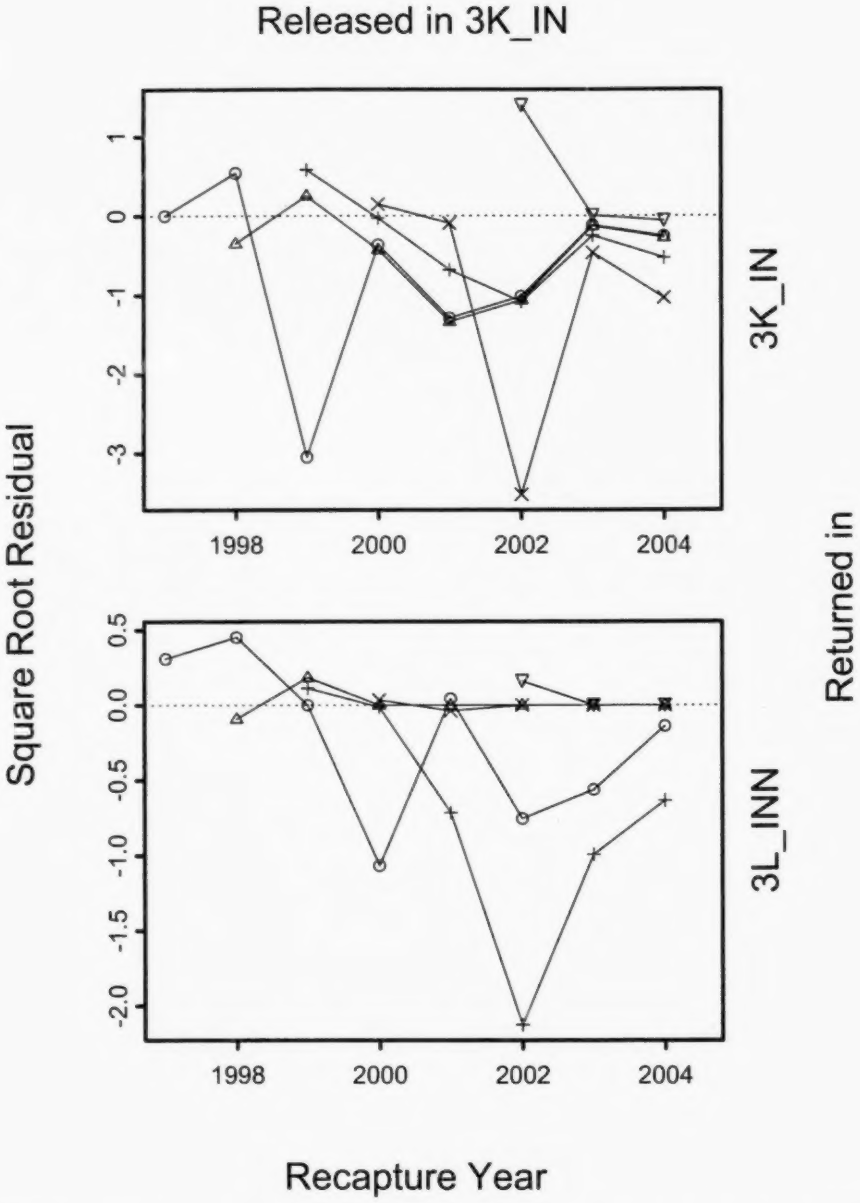


Fig. 41. Annual tag-recapture residuals (square root observed minus predicted) for cod tagged in 3K_IN, and recaptured in 3K_IN and 3L_INN. M=0.5 in 3K_INN and M=0.2 in 3L_INN. The symbols denote release years: ○ 1997, △ 1998, + 1999, × 2000, ◇ 2001, ▽ 2002. Trends in 2003-04 are discounted because of the low numbers of returns in these years.

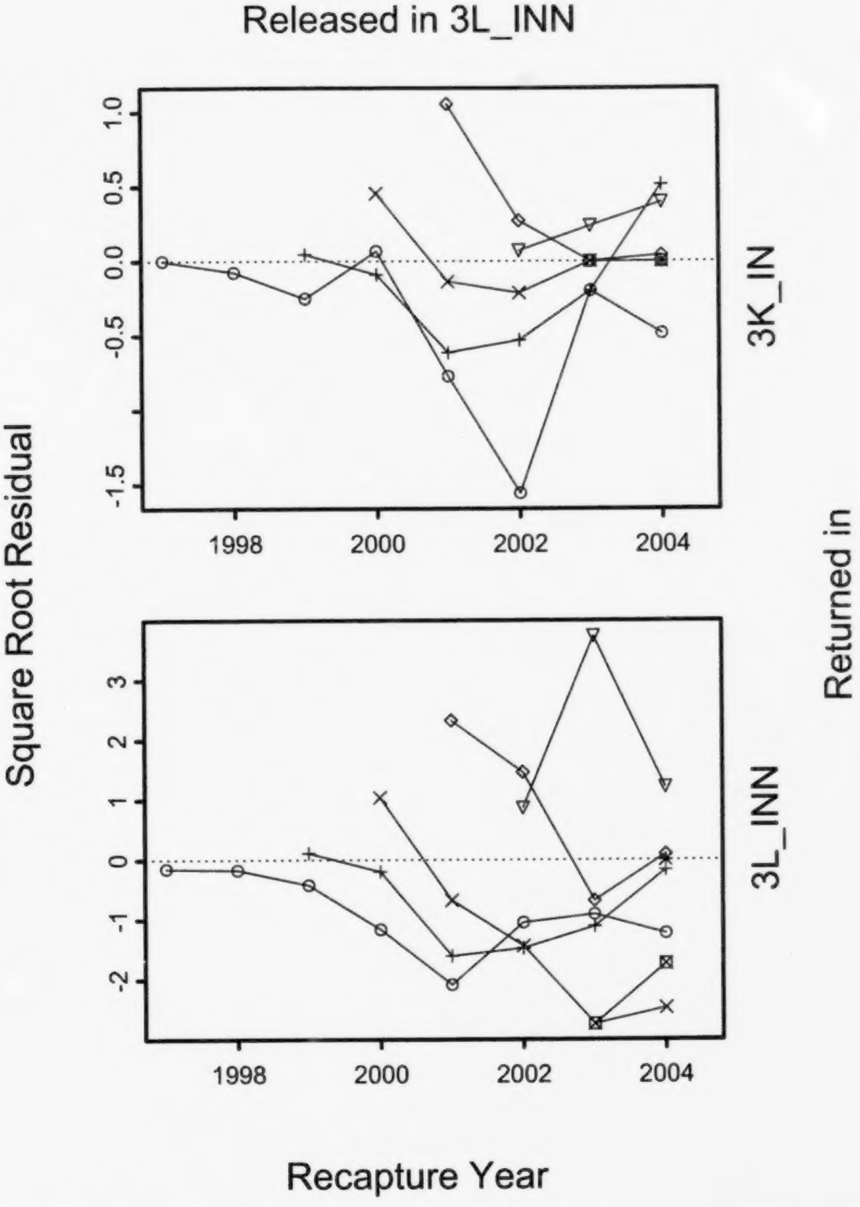


Fig. 42. Annual tag-recapture residuals (square root observed minus predicted) for cod tagged in 3L_INN, and recaptured in 3K_IN and 3L_INN. M=0.5 in 3K_INN and M=0.2 in 3L_INN. The symbols denote release years: ○ 1997, △ 1998, + 1999, × 2000, ◇ 2001, ▽ 2002. Trends in 2003-04 are discounted because of the low numbers of returns in these years.

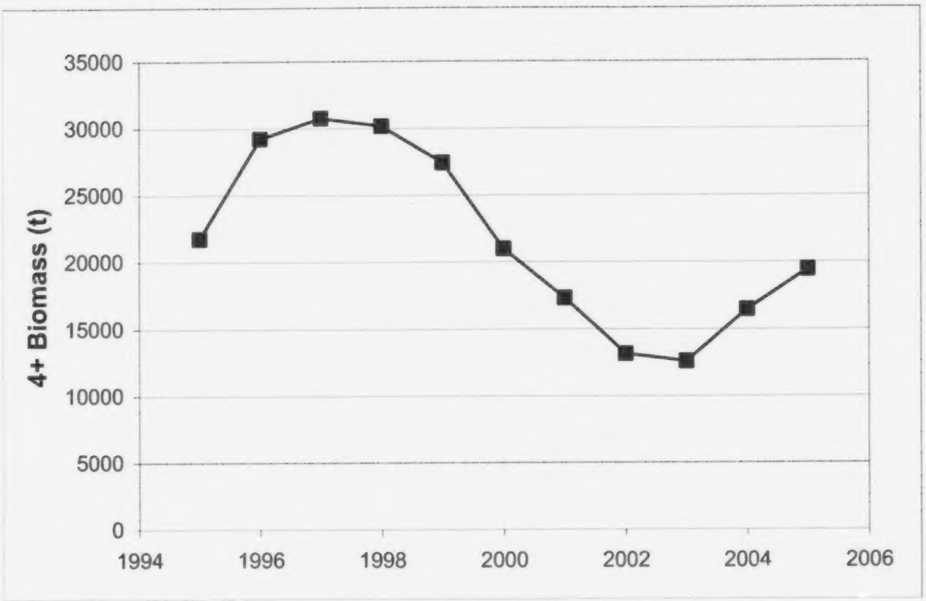


Fig. 43. Central inshore SPA. Estimates of exploitable (4+) biomass (tons).

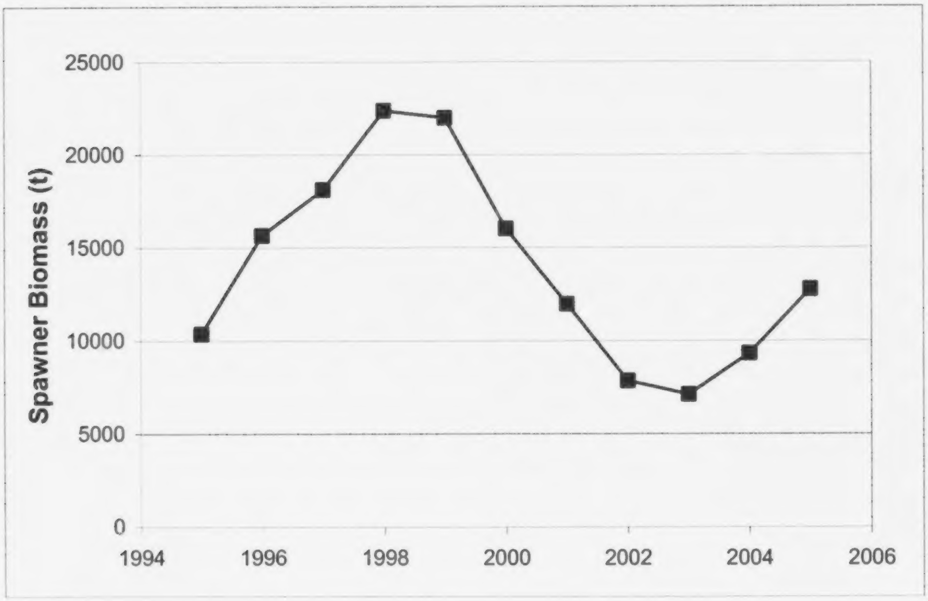


Fig. 44. Central inshore SPA. Estimates of spawner biomass (tons).

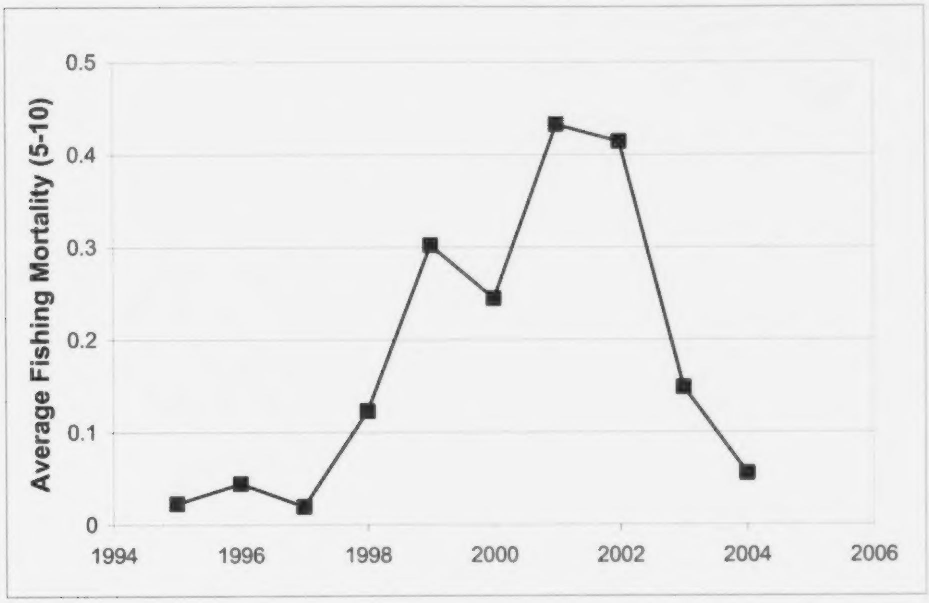


Fig. 45. Central inshore SPA. Estimated fishing mortality (average ages 5-10+).

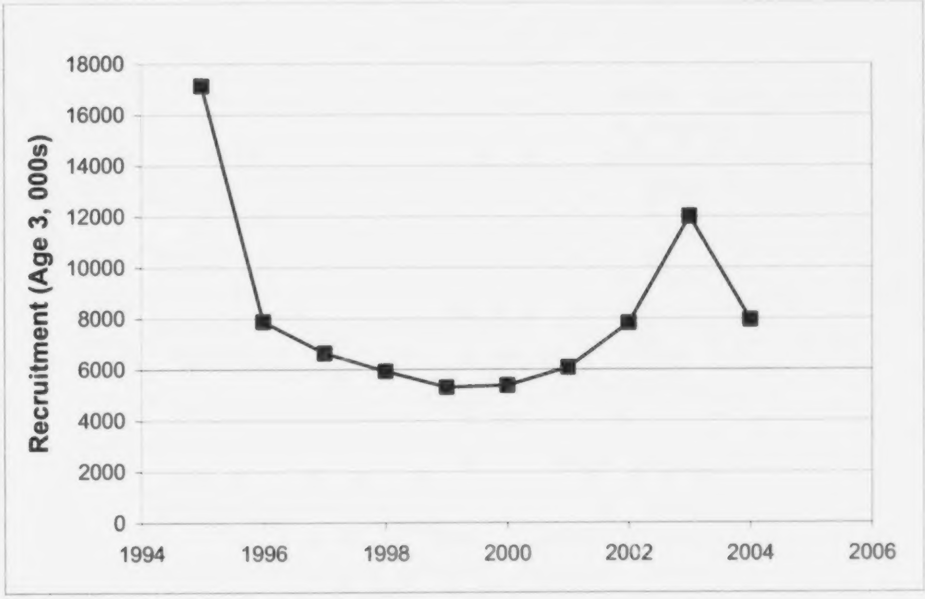


Fig. 46. Central inshore SPA. Estimated recruitment (age 3; thousands).

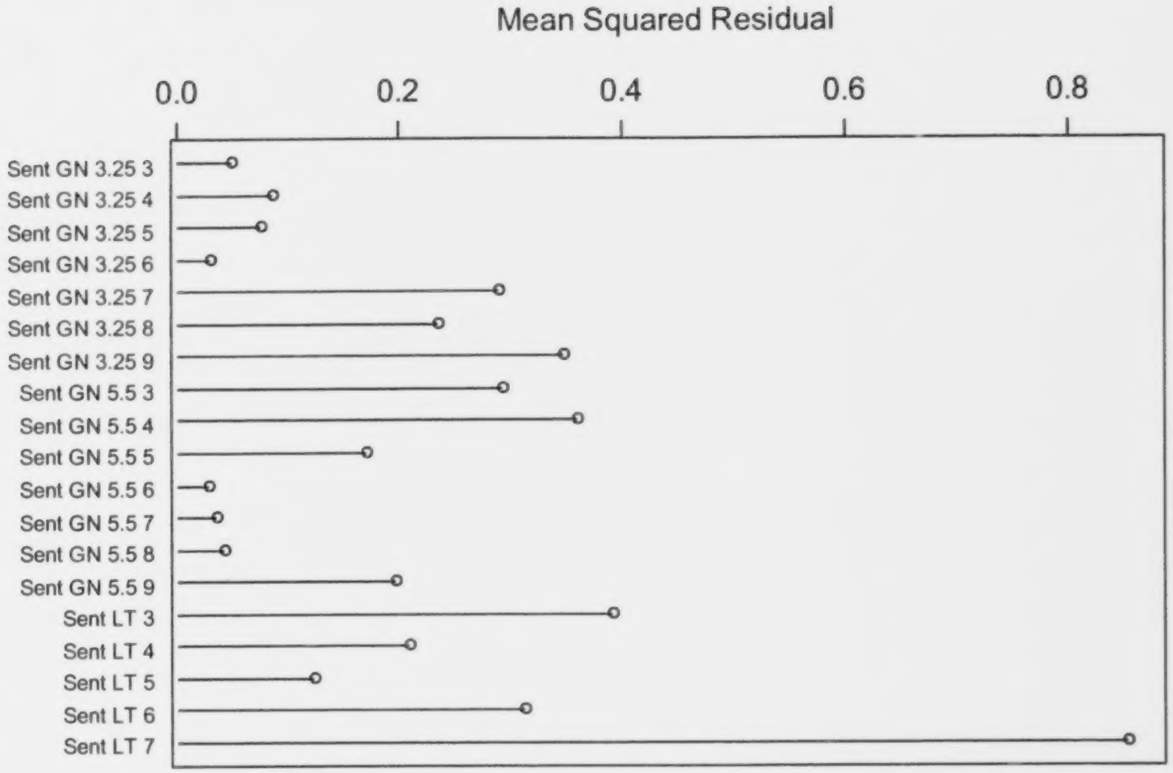


Fig. 47a. Central inshore SPA. Mean squared residual for each index-age.

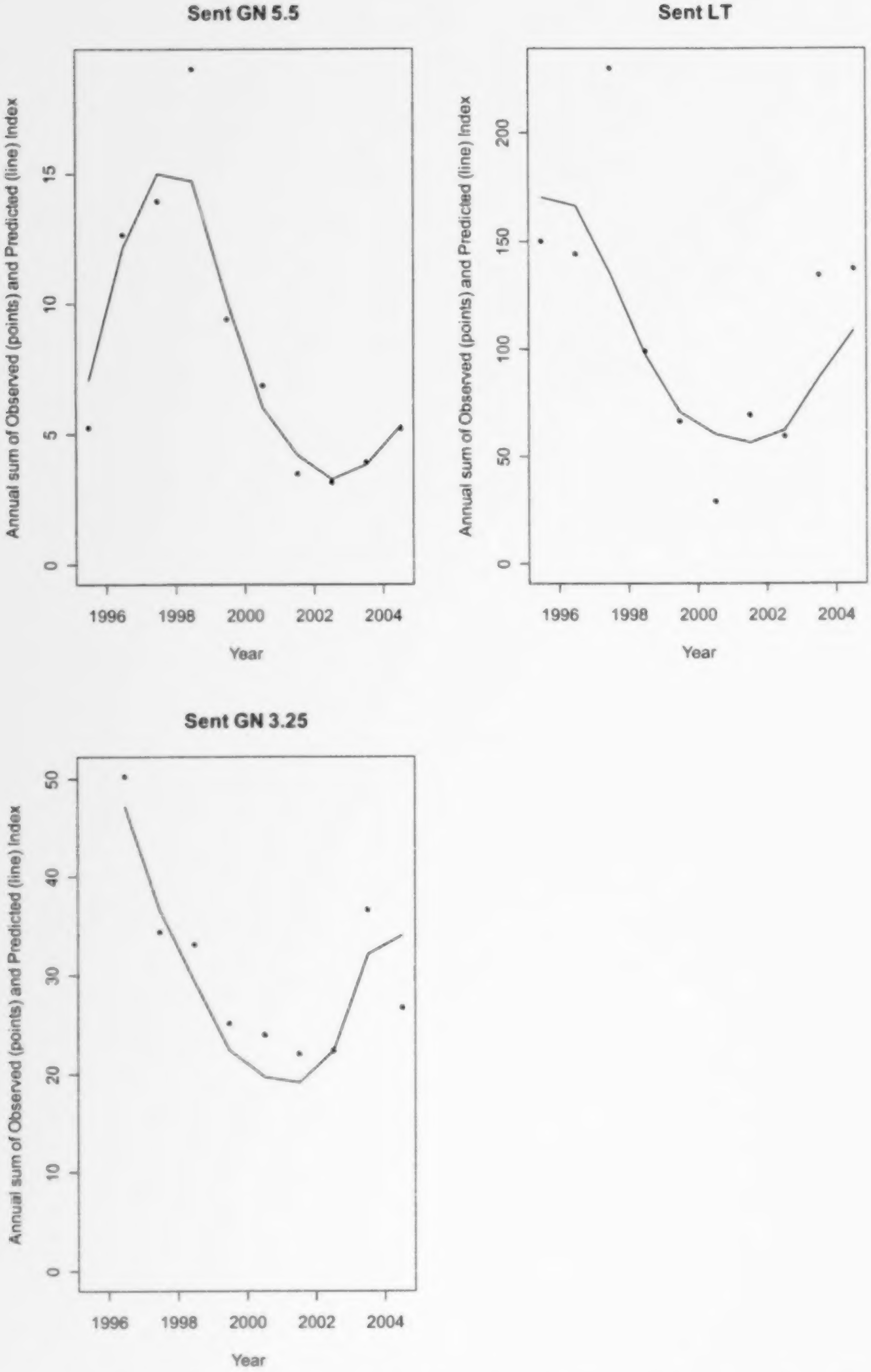
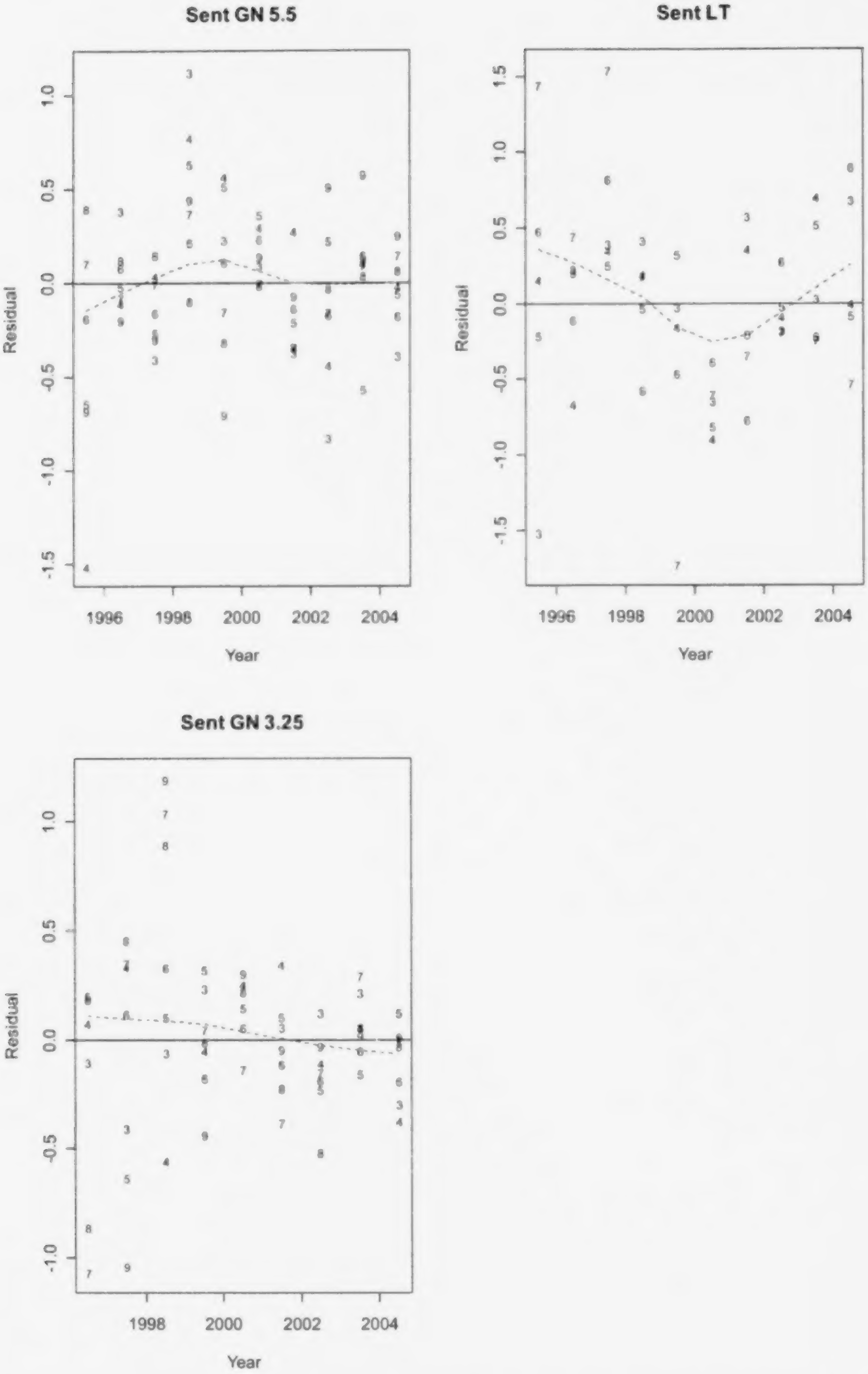


Fig. 47b. Central inshore SPA. ADAPT residuals: Observed and predicted survey indices.



Sent GN 5.5

Sent LT

Sent GN 3.25

Fig. 47c. Central inshore SPA. ADAPT residuals: Annual residuals for each index, with symbol=age.

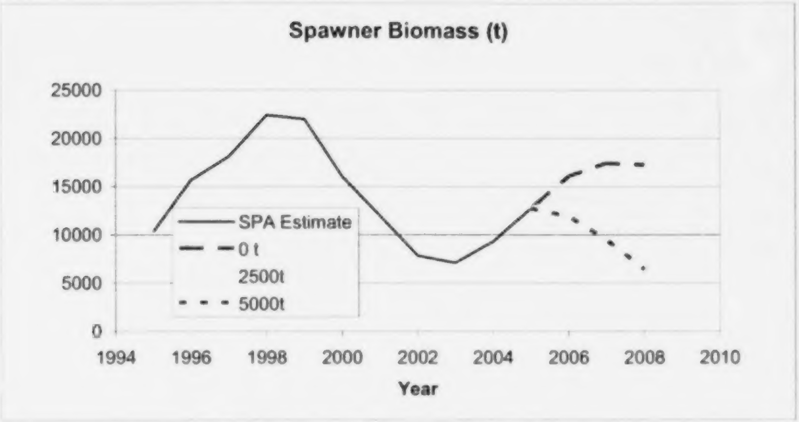


Fig. 48a. Projected trajectory (deterministic) of spawner biomass under three catch options, assuming low recruitment levels in the projection period.

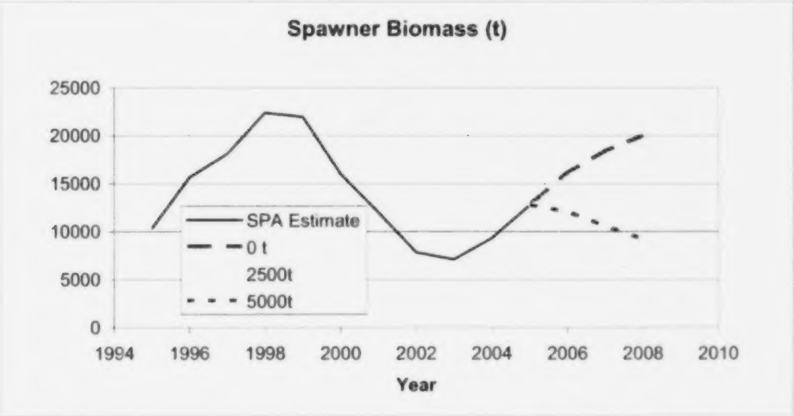


Fig. 48b. Projected trajectory (deterministic) of spawner biomass under three catch options, assuming medium recruitment levels in the projection period.

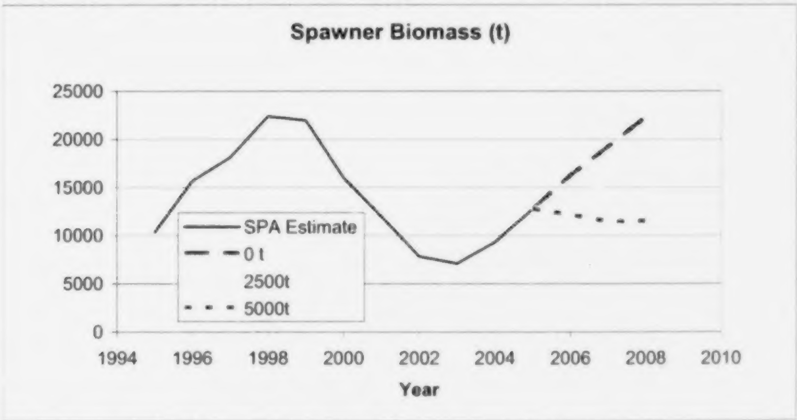


Fig. 48c. Projected trajectory (deterministic) of spawner biomass under three catch options, assuming high recruitment levels in the projection period.

Appendix 1. Objectives for the assessment

The assessment of 2J3KL cod is the result of a request for science advice from the Fisheries and Aquaculture Management (FAM) Branch – Newfoundland and Labrador Region. The Terms of Reference for the assessment were as follows:

- Review the evidence regarding whether populations of cod currently inhabiting inshore waters are self-sustaining and distinct from populations that historically overwintered and spawned in the offshore and migrated seasonally to the inshore.

- Assess current status of offshore populations, inshore populations and the stock as a whole. In particular, assess current spawning biomass, total (age 3+) biomass, exploitation rate, natural mortality and biological characteristics (including age composition, size at age, age at maturity, and distribution). Describe these variables in relation to historic observations.

- Highlight major sources of uncertainty in the assessment, and where appropriate, consider alternative analytical formulations of the assessment.

- To the extent possible with available information, provide information on the strengths of year-classes expected to enter the exploitable populations in the next 1-3 years.

- Assess the implications of inshore fishery removals varying from zero to 5,000 t annually in 2005 and the medium term. Implications are to be assessed with respect to growth of inshore populations, growth of offshore populations, and recovery of the stock as a whole.

- Assess geographical and seasonal variability in the density and migration patterns of cod in the inshore, and the extent to which such variability affects the quantity of cod available to fish harvesters both regionally and seasonally. What are the implications for regional vulnerability to exploitation?

- The assessment will be conducted in manner which is inclusive of the principles of the precautionary approach, which acknowledges that caution must be exercised to safeguard fisheries resources and ocean ecosystems. The precautionary approach recognizes that the absence of full scientific certainty shall not be used as a reason to postpone decisions where there is risk of serious or irreversible harm.

Appendix 2. Management regulations during 1996-2002

Table 1 summarizes management regulations in place during the five years of the inshore index/commercial fishery (1998-2002).

Table 2 provides details regarding opening and closing dates for individual geographic areas of the inshore during the 2002 fishery.

Table 3 summarizes management regulations for the recreational/food fishery in 1996-2002.

Appendix 2. Table 1. Management regulations for the inshore index/commercial fishery in Div. 2J3KL in 1998-2002 (from J. Perry, Fisheries Management Branch, Newfoundland and Labrador Region, DFO).

Management	1998	1999	2000	2001	2002
TAC & Fishing Regime	TAC = 4,000t - Inshore = 3,000t (IQ=2,700lbs) - Offshore = 350t - By-catch = 275t - Sentinel = 375t	TAC = 9,000t - Inshore = 8,600t (IQ = 9,000lbs) - By-catch = 100t - Sentinel = 300t	TAC = 7,000t - Inshore = 6,600t - (IQ = 8,400lbs) - By-catch = 100t - Sentinel = 300t	TAC = 5,600t - Inshore = 5,200t - (IQ = 8,400lbs) - By-catch = 100t - Sentinel = 300t	Same
Fishing Restrictions	- Core fishers only to participate. - Fishers limited to the Lobster Fishing Area of their homeport (some exceptions for fishers near boundaries). - Fishing restricted to less than 12 miles from land.	- Fishers limited to NAFO division of their homeport. - Smith Sound and 5 mile buffer zone limited to residents.	- Fishers with access to Northern shrimp out of the fishery. - Efforts to limit concentration of effort around Cape Bonavista (3L split N/S).	Same	Same
Fishing Gear	Gillnets - Min 5 ½ inch mesh - 5 nets @ 50 fathoms - Gear tagging Longlines - #11 circle hook or 16J - 1,000 hooks	Gillnets - Mesh size 5 ½ - 6 ½ inch - 5 nets @ 50 fathoms Handlines - #11 circle hook - Max 3 per line Longlines - #11 circle hook - 2,000 hooks Gear tending requirements.	Gillnets - 6 nets permitted	Gillnets not permitted after September 30.	Same
By-Catch	- All cod charged against IQ. - When IQ taken, all groundfish fisheries closed to fisher.	Same	Same	Same	Same

cont'd

Appendix 2. Table 1 (cont'd)

Management	1998	1999	2000	2001	2002
Small Fish Protocol	- Min 45cm - Closures when small fish >15% of catch (min 7 days). Test fisheries prior to re-opening.	- Min 43cm	Same	Same	Same
Monitoring	- 100% DMP - Hail in for >35ft vessels - Observer coverage	- 10% Observer coverage targetted.	Same	Same	Some ports 100% monitored, some random.
Seasons	Sept. 24 – Oct. 16	July 8 – July 31 Sept. 6 – Nov. 13	June 26 – July 29 Sept. 11 – Nov. 31	July 9 – Nov. 30	Varied by area (Appendix 1 Table 2)
Data Collection	- Mandatory logbooks - Dockside sampling	Same	Same	Same	Same
Administrative Sanctions	Overruns of IQ to be deducted from following year IQ.	Same	Same	Withdrawn due to legal challenge	

Appendix 2. Table 2. Index fishery in 2J3KL in 2002. Dates of openings, by area. (from J. Perry, Fisheries Management Branch, Newfoundland and Labrador Region, DFO).

AREA		SEASON DATES
2J		July 30 - October 13, 2002
3K(a)	Cape Bauld to Harbour Deep Head	July 30 - October 13, 2002
3K(b)	Harbour Deep to Cape John	September 3 – November 10, 2002
	Cape John to Little Bay Head	August 19 – October 26, 2002
	Little Bay Head to North Head	September 16 – November 24, 2002
	North Head to Cape Freels	July 30 - October 13, 2002
	Bay of Exploits (Swan Island – Farmers Head)	July 30 – September 03, 2002 October 14 - November 17, 2002
3L	Bonavista Bay	July 30 – September 1, 2002 October 2 - November 5, 2002
	Trinity Bay	July 30 - September 1, 2002 September 16 – October 19, 2002
	Conception Bay	July 30 – October 13, 2002
	Southern Shore	July 30 – October 13, 2002
	Petty Harbor (Defined Handline Area)	July 30 - August 13, 2002. September 9 – November 2, 2002
	St. Mary's Bay	July 30 – October 13, 2002

Appendix 2. Table 3. Management regulations for the recreational/food fishery in Div. 2J3KL in 1996-2002 (from J. Perry, Fisheries Management Branch, Newfoundland and Labrador Region, DFO).

Management	1996-1998	1999	2000	2001	2002
Seasons	1996 – two weekends 1997 – no fishery 1998 – one weekend	July 30 – August 1 August 28 – August 30	August 25-27 September 2-4 September 23-24 (added due to poor weather)	July 18 – September 19 (Introduction of Marine Recreational Groundfish Licence Pilot Program)	August 1 – September 22 (Continuation of Marine Recreational Groundfish Licence Pilot Program)
Fishing Gear	Permitted: Hook and Line Rod and reel (baited hooks and artificial lures) Casting and trolling Not Permitted: Jiggers and jigging	Same	Same	Same	Same
Discarding	Not permitted for any species except Atlantic Halibut which must be released	Same	Same	Same	Same
Processing	Filleting not permitted.	Same	Same	Same	Same
Fishing Restrictions				Closure of Smith Sound and 5 mile buffer zone to non-residents	Closure of Smith Sound and 5 mile buffer zone to non-residents
Catch Limits	- 10 groundfish per day per individual - 50 groundfish per trip per boat - More than one trip per day is permitted	Same	Same	30 tags per licence holder	- 15 cod per licence holder in 2J3KL and 4RS3Pn - 30 cod per licence holder in 3Ps - Bag limit of 10 fish per person per day
Data Collection		Same	Same	Same Telephone survey	Same

Appendix 3. Groundfish conservation harvesting plan for 2004.

CONSERVATION HARVESTING PLAN
GROUNDFISH
VESSELS LESS THAN 65 FEET
FIXED GEAR

NAFO AREA 2 and Divisions 3KL

This Conservation Harvesting Plan (CHP) applies to all vessels less than 65 feet in length, regardless of homeport, fishing Groundfish in NAFO Divisions 2 and 3KL using fixed gear and is effective June 1, 2004.

This CHP applies to the following species for the management cycle April 1 to March 31:
2J3KL Lumpfish
3KL Winter Flounder (Blackback)

GENERAL PROVISIONS

The following applies to **all fisheries** covered by this Conservation Harvesting Plan:

A **fishing trip** will start from the time you leave port and end when you return to port for any reason, whether or not you have any fish.

A) FISHING GEAR

GILLNETS

1. When fishing any species of Groundfish, you are required to report any lost gillnets to the nearest DFO office within 72 hours, if the loss is noticed before the closure of a fishing area. If the fishing area is already closed, the loss must be reported within 24 hours.

2. You cannot fish with or have onboard your vessel a Groundfish gillnet unless a tag, issued under the authority of the Minister to you for the current year, is securely attached to the head-rope of the net in a manner for which the tag was designed.

3. The gillnet tag must be affixed to the head rope of each gillnet within 1.85meters (6 feet) from the side rope on the end of the net where the float or buoy identifies the Vessel Registration number.

4. Unless otherwise stated in Species Specific conditions, all gillnets used in Groundfish fisheries cannot exceed 50 fathoms in length.

B) FISHING RESTRICTIONS – *See Species Specific Provisions*

C) MONITORING

1. With the exception of Lumpfish, all vessels are subject to 100% Dockside Monitoring.

2. Industry-funded at-sea observer coverage is required. The targeted level of coverage will be 5% of the fleet sector quota.

Test Fisheries

1. If a fishery is closed as a result of either high incidental catch levels or small fish, reopening will only be considered following a successful, observed, industry funded test fishery.
2. Test fishing will not commence until day 9 of the closure (day 13 in the case of excessive incidental catch of crab).
3. Where test fishing is conducted, a fishing plan will be developed which will include:
    - areas to be tested
    - quantity of gear to be used
    - depth strata to be tested
    - vessels to be used
    - dates when test fishing will be carried out
    - provision for at-sea observer coverage
4. Test fishing will not commence until the fishing plan has been approved by DFO.

D) INCIDENTAL CATCH

For the purposes of this CHP, the following definitions apply:

"Directed species" means the permitted species, or combination of species, retained on board and taken by the fisher at a time, in an area and by a means that is authorized in Species Specific Licence conditions.

"Incidental catch" means the catch retained on board of any species other than a directed species as defined above.

Unless otherwise stated, incidental catch restrictions are always expressed as daily limits (00:01 hours to 24:00 hours local time) and are always calculated using round weights.

Unless otherwise stated, incidental catch restrictions expressed as a percentage are always calculated as a percentage of the round weight of the directed species retained onboard.

When directing for any species of groundfish or combination of groundfish in NAFO Divisions 2GHJ3KL, the following incidental catch provisions apply:

1. Unless otherwise specified below or in species specific provisions, incidental catch of cod may not exceed 10% or 200 pounds whichever is greater.
2. When fishing in NAFO division 3L, the incidental catch of Redfish, American Plaice and Yellowtail Flounder may not exceed 5%.

The maximum amount of cod that can be caught incidentally by individual fishers in any and all groundfish fisheries is 2000 pounds (round weight). Once a fisher has landed this amount, the fisher must cease fishing all species of groundfish in 2J3KL.

Where there are widespread incidental catch problems, an entire area may be closed to the fleet sector.

E) DISCARDING

1. All Atlantic Halibut less than 81cm and northern and spotted wolfish must be released to the place from which it was taken and, when alive, in a manner that causes the least harm.
2. Dogfish and Lumpfish may be returned to the water immediately, dead or alive.
3. Live Winter Flounder less than 25cm and American Plaice less than 20cm in length may be returned to the water immediately.

F) OTHER

Closures

1. If a fishery is closed due to incidental catch or small fish problems, closures will be in effect for a minimum of 10 days.
2. If a fishery is closed, it will not reopen until it can be effectively monitored and controlled (see Test Fishery Protocol above).
3. If a fishery in a particular area is closed twice during the year, it may remain closed for the remainder of the year.

NAFO Regulatory Area

When fishing in the NAFO Regulatory area outside Canadian waters, the captain of the vessel must abide by the NAFO Conservation and Enforcement Measures.

Other conservation measures may be identified and implemented during the year as required.

SPECIES SPECIFIC PROVISIONS – LUMPFISH

In addition to the provisions outlined for all Groundfish fisheries, the following apply to the **Lumpfish** fishery in 2GHJ3KL:

A) FISHING GEAR

The maximum number of gillnets permitted is 40.
The minimum mesh size is 10 ½ inches (268mm)

B) FISHING RESTRICTIONS

Fishers are restricted to fishing the lumpfish area of their homeport or an area of their choice which will be identified in their conditions of licence.

C) MONITORING – *See Also General Provisions*

Although Lumpfish landings are not subject to dockside monitoring requirements, any cod landed in the directed Lumpfish fishery in Bonavista Bay South and Trinity Bay is subject to 100% DMP.

D) INCIDENTAL CATCH

When directing for Lumpfish, incidental catch of cod may not exceed 10% or 100 pounds whichever is greater.

E) DISCARDING – See General Provisions
F) OTHER – See General Provisions
G) VALIDITY PERIOD

Area	Opening	Closing
Cape Bauld to Granite Point	May 24	June 14
Granite Point to Little Harbour Deep Head	May 24	June 14
Little Harbour Deep Head to Cape St. John	May 24	June 14
Cape St. John to North Head	June 5	June 25
North Head to Cape Freels	May 24	June 14
Bonavista Bay (north)	May 11	June 4
Bonavista Bay (south)	June 7	June 28
Trinity Bay	June 9	June 29
Conception Bay	June 21	July 12
Southern Shore	June 19	July 9
St. Mary's Bay	May 17	June 7

Note: The dates indicated above reflect seasons requested by industry on June 2, 2004.

SPECIES SPECIFIC PROVISIONS – Winter Flounder(Blackback)

In addition to the provisions outlined for all Groundfish fisheries, the following apply to the **Winter Flounder (Blackback)** fishery in 3KL:

A) FISHING GEAR

GILLNETS

- The maximum number of gillets permitted is 30.
- Minimum mesh size is 6 ½ inches and maximum mesh size is 8 ½ inches.

B) FISHING RESTRICTIONS

Fishing is permitted only in water depths less than 15 fathoms.

Fishers are restricted to the NAFO Division of their homeport.

For fishers based in 3L, the following further restrictions apply:

1. If your homeport is in Bonavista Bay or Trinity Bay (Cape Freels to Grates Point) you are only permitted to fish north of a line drawn due east from Grates Point at 48 degrees 10'N.
2. If your homeport is in Conception Bay, Southern Shore or St. Mary's Bay (Grates Point to Cape St. Mary's) you are only permitted to fish south of a line drawn due east of Grates Point at 48 degrees 10'N.
3. If your homeport is Daniel's Cove or Old Perlican in Trinity Bay, you are also permitted to fish that portion of Western Conception Bay situated between Grates Point and Bay-de-Verde.
4. If your homeport is Grates Cove, Red Head Cove or Bay de Verde in Conception Bay, you are also permitted to fish that portion of Eastern Trinity Bay situated between Old Perlican and Grates Point

C) MONITORING – *See General Provisions*

D) INCIDENTAL CATCH

When directing for Winter Flounder (Blackback), the incidental catch of cod cannot exceed 20% or 300 pounds per day.

Where excessive incidental catch of cod occurs in a particular area, that area will be closed to directed fishing:

E) DISCARDING – See General Provisions
F) OTHER – See General Provisions

G) VALIDITY PERIOD
July 19 to August 20

Appendix 4. The inshore cod of Divisions 3K and 3L.

[This Appendix is reproduced from Lilly and Murphy (2004). Much of the information is extracted directly from Lilly et al. (1999), with some sections updated from Lilly et al. (2003).]

Templeman (1962, 1979, 1981) used information from vertebral numbers, tagging studies, time and location of pre-spawning and other aggregations, times and places of spawning, and ancillary information such as growth pattern and relative year-class strength, to determine stock structure within Atlantic Canada. His Labrador – East Newfoundland stock complex, which was defined largely on the basis of high vertebral averages, occupied the area from northern Labrador to Div. 3L. The two northern divisions (2GH) have been managed as a separate stock since the early 1970s, in part because some of their characteristics, such as growth rate, appeared different from fish in 2J (ICNAF 1973), and in part because the severe fishing of the 1960s had a greater impact in 2GH than in areas to the south (Pinhorn 1976).

The 2GH and 2J3KL stocks are not isolated entities. There are very few cod north of Div. 2G on the North American side of the Labrador Sea and Davis Strait, but there is some support for the hypothesis that the northern Labrador Shelf may occasionally receive larvae from West Greenland (Templeman 1981; Dickson and Brander 1993). There is no evidence that this has happened to a significant degree for several decades.

There obviously has been intermingling between the 2GH and 2J3KL stocks. Indeed, as noted above, the distinction between the two is weak.

The 2J3KL cod stock intermingles with the 3NO stock on the plateau of Grand Bank, with the 3Pn4RS stock in the area of the Strait of Belle Isle, and with the 3Ps stock near the coastal region of 3L.

The inshore region of Div. 3KL has gained a greatly increased degree of prominence in the assessment of 2J3KL cod since the mid-1990s. By the autumn of 1994 there appeared to be very few cod left within the boundaries of the 2J3KL stock complex. In spring 1995, a research vessel unexpectedly found a dense aggregation of cod in Smith Sound, Trinity Bay, and during summer/autumn of 1995 participants in the new sentinel survey program experienced good catch rates of commercial size cod over much of the area from central 3K to southern 3L. In 1998 a TAC was reintroduced to the inshore for vessels less than 65 feet in length, and this fishery continued through 2002.

Information on the general biology (e.g. distribution, spawning, feeding, growth, condition) of cod in the inshore may be found in Lilly et al. (1998a) and Lilly et al. (1999), and in the many sources cited therein. Our knowledge of the biology of cod in the inshore increased rapidly after the mid-1990s through interviews with fishermen (e.g. Neis et al. 1999; Hutchings and Ferguson 2000; Jarvis and Stead 2001) and an intensification of study, including a tagging program, sentinel surveys, a logbook program for commercial vessels under 35 feet in length, acoustic surveys in specific areas, and an extension of the autumn survey into new strata in the inshore.

A4.1 Definitions of inshore and offshore

The terms "inshore" and "offshore" have created some confusion within assessment meetings in the past. There was a request during the 1998 cod zonal assessment meeting for clear and unambiguous definitions. This may not be possible. It is recognized that a cod trap set within a few metres of land is in the inshore and a trawler fishing on the outer edge of Funk Island Bank is in the offshore. However, there is no distinct dividing line between the two. For example, a 55 foot vessel might set gillnets at various depths and at various distances from shore, such as follows: at a depth of 40 m close to shore adjacent to gillnets set by a 30 foot vessel; at 250-300 m some 25 nautical miles northeast of Cape Bonavista; or at 40 m on the plateau of Grand Bank near grounds fished by large otter trawlers. Which of these fishing operations are inshore and which are offshore?

For many years it was the custom within the documentation of the 2J3KL assessment to refer to all landings from fixed gear (traps, gillnets, and various types of hook and line) as inshore and landings from mobile gear (otter trawls) as offshore. The terms were also used in quota allocation, whereby there was for many years a quota for the stock as a whole, but the "inshore" was given an allocation which it was permitted to overrun. In this context, only vessels less than 65 feet in length were considered to be part of the inshore fleet. (It may be noted that in some contexts there is additional classification by vessel size, so that one may see vessels less than 35 feet referred to as "inshore", vessels 35-65 feet as "nearshore" and vessels 65-100 feet as middle distance.) The definition by gear type would not be a problem if fixed gears were deployed only close to the coast. However, longliners had been introduced to eastern Newfoundland waters in the early 1950s to exploit the aggregations of cod found in the deep water off the headlands, such as off Cape Bonavista. In these waters they overlapped the fishing areas of distant-water trawler fleets. Definition by gear type became much more problematical in the mid-1980s as the longliner fleet (which became predominantly a gillnet fleet in the 1960s) started to move further offshore, especially onto the plateau of Grand Bank. The inshore component was then clearly overlapping areas that had been fished with otter trawls for decades, and some of the catch in the inshore allocation was actually coming from far offshore. (It is worth recalling that, in an historical context, the plateau of Grand Bank was fished with longlines for centuries, and dory vessels continued to fish the plateau of the bank into the 1960s.)

The terms inshore and offshore have recently been used with respect to the geographic coverage by the research trawl surveys. When the stratification scheme was established, it was decided that the strata would not include the 12-mile coastal zone (Doubleday 1981; p. 24). Starting in the autumn of 1996, new strata were established closer to shore and within the bays of Divisions 3K and 3L. These new strata have been referred to as being inshore, to distinguish them from the older strata that are referred to as offshore. However, it appears that these strata do not extend into the shallow, very near-shore coastal area in which most of the sentinel surveying has been conducted since 1995, and in which most of the commercial fishing was conducted in 1998-2002.

Thus, there is no correspondence between the inshore as defined for allocating quota, inshore as sometimes employed in assessments for aggregating the fixed gear catch, and inshore as used in discussing the research surveys. The terms "inshore" and "offshore" are widely used within the fishing industry and are convenient terms of geographic reference in general discussion, but at present their usage is not consistent among all contexts.

A4.2 Observations of cod in the inshore

Cod in Divisions 2J3KL historically migrated on a seasonal basis between a summer-autumn feeding area in shallow water along the coast of southern Labrador and eastern Newfoundland and an overwintering area offshore, primarily near the shelf break. However, not all cod moved offshore in the winter. Some remained near the coastal shelves in deep water below the Cold Intermediate Layer (CIL) of the Labrador Current, and some remained within the bays of eastern Newfoundland, often in narrow fjord-like environments. In recent years the quantity of cod caught during autumn research bottom-trawl surveys in offshore waters has been very low, but there have been numerous reports of cod in shallow coastal waters, catch rates have been good to excellent in sentinel surveys from White Bay south, and dense aggregations of cod have been found and studied in deep inlets in the inner reaches of Trinity Bay.

A4.2.1 Linking the inshore to the offshore

Several studies in the 1960s demonstrated a close association between the cod caught in inshore waters and the cod caught on the outer shelf. The most compelling information was the pattern of returns from tagging studies in both the offshore and the inshore in the early to mid-1960s (Postolakii 1966; Templeman 1974) but there were also analyses of catch rates, fish size and growth rate. Fleming (1965), Hodder (1965) and May (1967) showed that the catch per fisher in the inshore declined as catches by distant-water fleets increased in the offshore in the late 1950s and early 1960s. Referring to sampling during 1955-1962, Hodder (1965) concluded: “The decreased abundance of fish older than 6 years in the inshore trap fishery is attributed to the decreased abundance of these older ages on the offshore fishing grounds as a result of increased effort by trawlers in all areas off the east coast of Newfoundland and southern Labrador in recent years.” May et al. (1965) used random samples of research vessel trawl catches and catches by various gears in the inshore commercial fishery in 1960-1962 to calculate mean length-at-age of cod in ICNAF Divisions from 2H to 3Pn. They found that von Bertalanffy growth curves “... derived from the offshore data provide an adequate representation of the inshore material as well, lending evidence to the hypothesis that there is no inshore-offshore stock separation in the areas concerned.” It should be noted, however, that the inshore samples came from communities on headlands and exposed coasts, and may have been dominated by migrating fish.

A4.2.2 Cod in deep waters off headlands

The presence of cod in deep water off the coastal shelves of eastern Newfoundland has been recognised since exploratory longlining in the early 1950s (Templeman and Fleming 1956, 1963). Not all the cod in these areas, just below the depth at which the Cold Intermediate Layer of the Labrador Current impinges on the bottom, arrived from near the shelf break following spawning. In the 1980s the fishery in the deep water started each spring very soon after the disappearance of the ice, and often long before the sudden increase in landings toward the middle or end of June in adjacent shallow waters (G. Lilly, unpubl. data). In addition, research trawling off Cape Bonavista and in the mouth of Trinity Bay has yielded good catches in

February-April (Lilly 1982; unpubl. data). Thus, some cod are in this deep-water coastal environment months before the migration of cod from the offshore. Templeman (1962) presented several arguments in support of a suggestion that "... each large shelf region, such as the Bonavista Shelf, the Fogo Shelf and the St. Anthony Shelf, projecting seaward with deep water on each side has a basic stock of its own, some of which it loses temporarily in the summer by coastal or pelagic feeding migrations and in the winter by movements in the deep water, while receiving some migrants from other areas."

As reported by Hutchings et al. (1993), there is evidence of spawning in the deep water off Cape Bonavista. Cod caught in the commercial gillnet fishery northeast of the Cape in 275-350 m were sampled weekly in 1983 and 1984. A plot of a gonad-somatic index versus time illustrates that there were many cod with relatively large gonads when the first samples were collected (May 11 in 1983 and May 30 in 1984), and that the proportion of cod with elevated indices, and the maximum values of the indices, declined to a minimum by the middle or end of July (Lilly 1996). The decline in gonad indices provides only circumstantial evidence that cod spawn in deep water off the Bonavista Shelf. The cod with low gonad indices could have spawned elsewhere before migrating into the area, and cod with large gonads may have moved elsewhere to spawn if they had not been caught.

A4.2.3 Cod in eastern bays

Reports of the presence of cod in spawning condition in the bays of eastern Newfoundland may be found in the scientific literature as early as the 1890s, when Neilsen described how he obtained fish in spawning condition for the Dildo Island Marine Hatchery in May-June in Trinity Bay. In discussing an early run of cod at the head of Trinity Bay in 1894, Neilsen (1895) was of the opinion that the "... early occurrence of fish seems clearly to indicate that those fish do not enter the bay from the outside, but that they are *local-bred* fish, which keep in deep water during winter, and on the first opportunity in the spring, seek the shoaler waters in the head of the bay ...".

Additional evidence of the presence of spawning cod within eastern bays may be found in unpublished trip reports (Marinus 67-1, 68-1, 68-2) which describe the maturity of cod caught during experimental gillnetting in the deep water of Trinity and Bonavista bays. These data have been summarised by Hutchings et al. (1993). Cod were caught with 6- and 7-inch mesh monofilament gillnets off Tickle Harbour Point and the Horse Chops in Trinity Bay and near Little Denier and Cabot Island in Bonavista Bay in April-June of 1967 and 1968. All gillnet sets were made in deep water with the nets usually running from cold water into the underlying warmer water. In 1967 many of the cod were in spawning condition or close to it (Fleming 1967), and in 1968 the cod were in maturity stages indicating spawning was soon to occur (Fleming 1968). Fleming (1968) thought that the gillnet experiments were sampling "... a segment of the stock which ... consists of large old cod which have escaped other gears, and which spawn in the coastal areas and bays in contrast to the younger fish being caught by traps and handlines which spawn before arriving in the coastal areas in the spring."

It is interesting to note that Templeman (1962) considered his Avalon-Burin stock to be "... an inshore stock ... extending from the outer coast of the Avalon Peninsula into Fortune Bay". In concluding his discussion of the Labrador-Newfoundland stock, he stated: "Very likely in the future enough differences will be found to indicate a number of north-south and inshore-offshore sub-stocks ..." (Templeman 1962). However, Templeman did not present evidence of inshore stocks north of the Avalon Peninsula (other than the coastal shelf "sub-stocks" discussed above), and he did not speak of "bay stocks".

A4.2.4 Cod in fjord-like environments

Cod have for many years been caught through holes cut in the ice in sheltered inlets and embayments of the east and northeast coasts (e.g. Neis et al. 1996). The only such areas that have been studied extensively using scientific techniques are the three fjord-like arms near Random Island on the western side of Trinity Bay.

Most attention in the late 1980s and early 1990s was focused on the two southern arms (Northwest Arm and Southwest Arm) where DFO and especially the Fisheries Oceanography Group at Memorial University of Newfoundland conducted tagging experiments and documented various aspects of the biology of cod that overwintered inshore, including their movements and spawning (Wroblewski, et al. 1994, 1995a; Smedbol and Wroblewski 1997).

The focus shifted to Smith Sound following discovery of a large and dense aggregation of cod in spring 1995 (Rose 1996; Brattey 1997; Morgan and Brattey 1997; Brattey and Porter 1997; Porter et al. 1998; Rose 2003) There is much evidence that cod have always overwintered in this area, but the recent winter/spring aggregations appear to be much larger than people were aware of in the past. There seems to be a general pattern of cod aggregating in the Sound in the winter and moving out sometime in spring, but the timing of these movements is not well understood.

A4.2.5 Cod in the shallow-water fishery

Cod in shallow water along the coast of southern Labrador and eastern Newfoundland supported a fishery with hook and line for centuries. Since the late 19th century this fishery has been strongly augmented by the use of the cod trap, and since the 1960s by the use of synthetic gillnets. The geographic pattern of the catch in 1947-1949 does not support the supposition that "bay stocks" made important contributions to the total inshore catch. Templeman (1958) stated: "Within the east coast area, cod are most abundant near the projecting island and headland areas such as the Cape Bauld - St. Anthony, Fogo Island, Cape Freels, Cape Bonavista, Bay de Verde - Grates Point areas and in the areas to the east of the Avalon Peninsula. … As a rule far fewer cod are available in the deep inlets and warmer water at the heads of the east coast bays than at the headlands."

In years prior to the collapse, areas of largest catch had in common a closeness to the schools of cod migrating toward the coast from their offshore overwintering areas. If all cod caught in the inshore shallow-water fishery arrived from the offshore, then the earliest landings would be expected at the headlands. However, substantial landings occurred in the inner parts of Bonavista and Trinity Bays several weeks prior to the big increase in landings at the tips of the headlands. See Lilly (1996) for some preliminary analyses of these patterns based on purchase slips. These patterns appear to correspond to the descriptions of herring fish and capelin fish as reported by fishers (Alverson et al. 1987, p. 28-29; Neis et al. 1996). Additional research is required to determine if the early landings (prior to about mid-June) in the inner parts of Bonavista Bay and Trinity Bay were supported by cod which remained within the bays throughout the winter and the later landings were supported by cod which migrated into the coastal areas from farther offshore.

It is tempting to speculate that cod taken in the early landings belong to "bay stocks". It would be of interest to determine if cod taken in the early landings differed from cod taken from later landings with respect to length-at-age, relative year-class strength, otolith structure, and other biological characteristics Unfortunately, the data required to conduct these analyses may not have been collected prior to the 1990's. Most routine sampling of inshore catch was conducted on the outer shores and headlands after mid-June. The early catch in the inner parts of the bays may have been rarely sampled.

A4.2.6 Recent observations of cod in shallow water

A surprising aspect of the cod currently in coastal waters is the large number of reports of cod being seen near the surface and cod being caught in shallow-water gear, including gillnets set for herring, lumpfish and winter (blackback) flounder. Cod have even been caught in lobster pots. Such reports were common in the mid-1990s (Neis et al. 1996; Davis 1996; numerous personal communications to scientists; communications in public media, such as the Evening Telegram, St. John's, NL, 25 May 1996, p.4) and are commonly heard today.

Reports of cod in shallow water became frequent in the winters of 1997-1998 and 1998-1999. These reports came primarily from two areas: Notre Dame Bay on the northeast coast and southwestern Bonavista Bay on the east coast. Reports from Notre Dame Bay included the following. On December 30-31, 1997, cod up to 3 feet (91 cm) in length were reported frozen in ice at Baytona, a community in the inner reaches of the bay. Observers noted the presence of smelt in the area. On January 6-7, 1998, cod were seen in ice near the Twillingate Causeway, which is further out in the bay. Harp seals were reported in the area. From January 11 to approximately January 16, 1999, cod were found dead and dying in and below ice in Virgin Arm, again in the outer part of the bay. It was estimated by Fishery Officers, who interviewed divers and other people who harvested the fish, that perhaps 200,000 lbs (91 t) of cod died. A sample (n=193) of these fish, obtained by divers, had a mean length of 59 cm (range 35-95 cm). The fish were to all appearances healthy and in good condition. Harp seals were reported in the area and some of the larger cod in the sample had bites taken from their bellies. In early February, 1999, a small number of cod were found frozen in the ice at Virgin Arm. Seals were in the area.

Reports from southwestern Bonavista Bay are similar but include more observations of predation by harp seals. On December 30, 1997, cod were observed chasing herring very close to shore in Cannings Cove. In early February, 1998, many dead cod were observed in Southern Bay Reach. Many harp seals were reported in the area. From February 28 to March 3, 1998, cod were seen swimming with fins above the surface, and 200 lbs of cod were found dead on the shore. Seals were reported in the area and an observer reported seeing a seal taking a bite out of a cod's belly. On January 11-13, 1999, many cod were observed swimming near the surface at Cannings Cove and Jamestown. Seals were again seen in the area and an observer reported seeing seals with cod in their mouths, shaking the cod and tearing out the guts. On January 20, 1999, an observer saw a very large number of seals near Deer Island (at the headland between Goose Bay and Sweet Bay) coming to the surface with cod in their mouths. They would take a clean cut out of the belly, taking the liver but leaving the gonad. As reported by The Telegram (St. John's, NL, February 23, 1999), in February 1999 seals were observed preying on cod in a small cove on Deer Island. The seals would shake the cod "and the gut would stay in the mouth and the fish would fly off". The presence of large numbers of dead cod on the bottom was confirmed by a diver. One cod recovered with a large bite from its belly was reported to be about 3 feet (91 cm) long. Divers harvesting sea urchins reported seeing large numbers of dead cod on the bottom in many parts of southwestern Bonavista Bay during the late 1990s.

A4.3 Stock relationships of cod in the inshore

A4.3.1 Did some migrating cod from offshore remain inshore?

It has been suggested that some of the cod that at one time migrated between the offshore and the inshore remained in the inshore in the early to mid-1990s, contributing to the dense aggregation first found in Smith Sound, Trinity Bay, in 1995 and to the high catch rates experienced by participants in the sentinel surveys. There have been several variants of this hypothesis.

One suggestion was that a major progressive change in migration behavior occurred in the early 1990s, resulting in cod remaining inshore during the entire year.

A second variant was proposed by G. Rose (Memorial University of Newfoundland, St. John's, Canada),who has been quoted as noting that there were almost no older fish in the northern cod population by 1992, and that it is possible that the survivors, mainly younger fish, came inshore and remained there (The Evening Telegram, St. John's, NL, 24 March 1996, p. 13; Kurlansky 1997, p. 203).

A third variant was proposed by Taggart (1997), who noted that an aggregation of cod that had been found in the North Cape area of Division 3L each year during the autumn research bottom-trawl surveys was last detected in 1993 and that the large aggregation of cod in Smith Sound was first detected in spring 1995. Based on these observations and the results of genetic and parasite studies, Taggart (1997) hypothesized that "the large aggregations of cod observed in recent years in the Random Island region of Trinity Bay may be those that would normally aggregate offshore in the North Cape region but for some reason have ceased their normal migration pattern to offshore for winter." He noted that this hypothesis could be tested by sampling the large aggregation in Smith Sound and comparing it genetically with fish sampled in the offshore.

The above three variants of the altered migration hypothesis differ with respect to timing. The change could have occurred in the early 1990s when most fish disappeared from the autumn research surveys, about 1992-1993 when cod disappeared from the migration corridor east of Bonavista Bay as recorded during spring-summer acoustic studies, or about 1994 when the last aggregation of cod disappeared from the autumn research surveys. If the change occurred early in the 1990s, then a very large quantity of cod could have been involved and these cod should have been comprised largely of the 1986 and 1987 year-classes. With increasing delay in the change, the quantity of cod available to remain inshore would decline and the age classes would be more recent.

The data available for testing the altered migration hypothesis are limited. The only sources of information on cod of commercial size in the inshore between 1991 and 1995 are the small fishery in 1992 prior to declaration of the moratorium on July 2, food fisheries in 1992-1994, bycatch in fisheries directed at other species, and the research being conducted in the arms of western Trinity Bay.

As noted above, autumn bottom-trawl surveys in the late 1980s were dominated by the 1986 and 1987 year-classes, which seemed to disappear very rapidly in 1991 and 1992. If these cod migrated to the inshore and remained there, then inshore catches and catch rates might be expected to be high and dominated by these year-classes. The 1991 inshore fishery, which was the last fishery to be unrestricted, was indeed dominated by the 1986 and 1987 year-classes, but the total catch in 1991 was dramatically lower than that in 1990, especially north of Division 3L (Baird et al. 1992a). This decline in inshore catch was not consistent with the suggestion that a large quantity of fish remained inshore. In 1992 the inshore catch, taken mainly by a "recreational fishery" using jiggers or baited hooks, was small and composed of mainly the 1985-1987 year-classes, with the 1987 year-class dominant (Bishop et al. 1993). "In both 1991 and 1992 there were some indications, based on the commercial and recreational fisheries, that cod may have remained in inshore waters later than usual and in significant numbers. During the autumn surveys, time was allotted for limited coverage (using the bridge sounder to detect fish and trawling where possible) of those areas which are not normally included in the regular survey area. The results indicated that very few cod were encountered in the inshore areas surveyed" (Bishop et al. 1993, p. 3). It may be noted, however, that experience in the late 1990s showed that cod may be shoreward of the area that can be surveyed by large vessels.

In 1993 there was a food fishery with no restrictions on season or quantity of fish taken. There is considerable uncertainty about how much fish was taken. The catch from recreational fishing and by-catch was mainly of the 1987-1989 year-classes, with the 1989 year-class at age 4 comprising 45% by number (Bishop et al. 1994). In 1994 there was a food fishery of just 1300 t. Based partly on the poor results of the 1993 food fishery (and to prevent large amounts of fish being taken) (Kulka et al. 1995a), the 1994 food fishery was limited to five Friday/Saturday periods in August and September. Most participants considered the food fishery to be a failure and it was closed a week early because of small fish and low numbers in the catches (Bishop et al. 1995; Kulka et al. 1995a). The catch from the recreational and by-catch fisheries in 1994 was mainly from the 1989 and 1990 year-classes, with the 1989 year-class at age 5 comprising 43% by number (Bishop et al. 1995). One should not place much weight on the performance of food fisheries, since much of the effort was by non-professionals and the gear was restricted to hook and line. Nevertheless, the poor results in the 1993 and 1994 food fisheries and the dominance of the 1989 and 1990 year-classes (rather than the 1986 and 1987 year-classes) are not consistent with the hypothesis that the fish that disappeared from the offshore moved inshore and remained there.

In 1995 much more information became available from surveys in Smith Sound and catches from the sentinel surveys. The 1990 year-class was dominant in Division 3K, whereas the 1989 and 1990 year-classes were both strong in Division 3L, with the 1989 year-class more prominent toward the south (Davis 1996; Brattey 1997; Lilly et al. 1998a). These results indicate that the high catch rates in the sentinel surveys were not supported by the fish that disappeared from the offshore surveys in approximately 1990-1992. It is possible, however, that there was a change in migration pattern somewhat later as postulated by Rose and Taggart (as cited above). However, once again the match in year-classes is not correct. The bulk of the fish inshore in the mid-1990s was represented by the 1989 and 1990 year-classes, both of which had been weak at age 3 in the offshore bottom-trawl surveys. There remains the possibility that individuals of the 1989 and 1990 year-classes found inshore in the mid- and late 1990s were recruited from offshore spawning and failed to migrate offshore after spending their first few years inshore.

The age compositions from the sentinel surveys (Lilly et al. 2003), commercial fisheries (Lilly et al. 2003) and samples of cod from Smith Sound (Porter et al. 1998; Rose 2003) are consistent with the hypothesis that the buildup of biomass in the inshore during the 1990s was largely due to the recruitment and individual growth of the 1990 and 1992 year-classes. These year-classes appear to have been very weak in the offshore.

A4.3.2 Tagging

Inshore tagging experiments prior to the late 1980s were conducted during the summer and autumn (Templeman 1974, 1979), and thus are not helpful in testing the hypothesis that there are inshore components that are distinct from components that migrate to the inshore from offshore. Recoveries from these experiments came from both the inshore and the offshore.

Tagging studies, conducted during the post-moratorium period while the overall stock size has been extremely low (Brattey et al. 2001), indicate that the inshore of 3KL is currently inhabited by at least two groups of cod: (1) a northern resident coastal group that inhabits an area from western Trinity Bay northward to western Notre Dame Bay and (2) a migrant group from inshore and offshore areas of 3Ps that moves into southern 3L and less commonly into northern 3L and 3K during late spring and summer and returns to 3Ps during the autumn. Only a small number of tagged cod from 3Ps were caught north of Trinity Bay. The tagging also indicates considerable movement of cod among Trinity, Bonavista and Notre Dame bays.

It is not known if there is currently movement between the inshore and the offshore in 2J3KL. Very few tags have been applied to cod in the offshore in recent years because no aggregations sufficiently large to warrant tagging have been located. In addition, there has been only one reported offshore recapture of a cod tagged inshore after the mid-1990s. Of course, any conclusion about the current existence or absence of inshore-offshore migration is tempered by the fact that there has been no directed fishery for cod in the offshore during this period, so recaptures could come only from fisheries directed at other species, and the by-catch of cod from these other fisheries is thought to be small relative to the cod-directed inshore catch.

A4.3.3 Genetics

There are two conflicting interpretations of genetic studies. One is that cod in the inshore and offshore are genetically distinct from one another; the other is that there is no differentiation among groups of 2J3KL cod. These differences originate in part in methodology.

The results of studies employing microsatellite loci are interpreted to support the existence of sub-stock structure between the inshore and the offshore and in various areas of the offshore (Bentzen et al. 1996; Ruzzante et al. 1996, 1997, 1998, 1999, 2000; Taggart et al. 1998; Beacham et al. 2002). Substock structure at the level of bays is less strongly supported. Beacham et al. (2002) summed up their findings by stating that northern cod conforms to an isolation-by-distance structure, with cod from more distant locations tending to be more distinct.

In contrast to the studies with microsatellites, the results of studies with mitochondrial DNA provide no evidence of substock structure within 2J3KL (Pepin and Carr 1993; Carr et al. 1995). The conflicting interpretations of stock structure are not just a consequence of the use of different methodologies. Carr and Crutcher (1998) state that "re-evaluation of (the) microsatellite data supports the conclusion of extremely limited genetic differentiation among populations in the Northwest Atlantic". Those who support the interpretation of considerable substock structure contend that the mitochondrial DNA approach lacks the ability to detect the structure that is there.

Neither interpretation of the genetic data would preclude the possibility that functional subpopulations exist without significant genetic differentiation.

An important question is whether the fish currently inshore can contribute to the recovery of fish in the offshore. Beacham et al. (2002) contend that "given the population substructure … detected between most inshore and offshore areas, and among offshore areas themselves, the likelihood that the inshore-spawning stock will contribute to offshore recovery is low."

A4.3.4 Productivity

Since at least the mid-1990s, the aggregations sampled inshore by commercial fisheries, sentinel surveys, and research bottom-trawling in Smith Sound contain individuals that are much older and larger than those taken by research bottom-trawling in the offshore, especially in Divisions 2J and 3K. This supports the contention that the cod in the inshore are experiencing a lower mortality rate than the cod in the offshore. It also supports the contention that there has been little movement of adult cod from the inshore to the offshore in recent years.

References

The references in this Appendix are included in the list at the end of the major portion of this paper.

Appendix 5. The collapse of 2J3KL cod. Some thoughts on the role of the environment

[This Appendix is reproduced from Lilly and Murphy (2004). The text has been extracted largely from Lilly and Carscadden (2002).]

A5.1 Changes in the ecosystem off southern Labrador and eastern Newfoundland

The ecosystem off southern Labrador and eastern Newfoundland has been characterised by a relatively small number of species, a few of which have historically occurred in high abundance (Bundy et al. 2000; Livingston and Tjelmeland 2000; Carscadden et al. 2001). The dominant fodder fish has historically been capelin, with Arctic cod more prominent to the north and sand lance (*Ammodytes dubius*) more prominent to the south on the plateau of Grand Bank. Herring (*Clupea harengus*) is found only in the bays and adjacent waters. These four species of planktivorous fish feed mainly on calanoid copepods and larger crustaceans, the latter being predominantly hyperiid amphipods to the north and euphausiids to the south. The dominant piscivorous fish has been Atlantic cod, but Greenland halibut (*Reinhardtius hippoglossoides*) and American plaice (*Hippoglossoides platessoides*) have also been important. Snow crab (*Chionoecetes opilio*) and northern shrimp (*Pandalus borealis*) have been the dominant benthic crustaceans. The top predators are harp seals (*Phoca groenlandica*) and hooded seals (*Cystophora cristata*), which migrate into the area from the north during late autumn and leave in the spring. Other important predators include baleen whales, most of which migrate into the area from the south during late spring and leave during the autumn. Additional immigrants from the north during the winter include many birds which spend the summer in the Arctic, and additional immigrants from the south during summer include short-finned squid (*Illex illecebrosus*), fish such as mackerel (*Scomber scombrus*) and bluefin tuna (*Thunnus thynnus*), and several species of birds.

The Labrador/Newfoundland ecosystem experienced major changes during the last two decades of the 20th century. Atlantic cod and most other demersal fish, including species that were not targeted by commercial fishing, experienced declines to very low levels by the early 1990s (Atkinson 1994; Gomes et al. 1995). In contrast, snow crab (DFO 2002b) and especially northern shrimp (DFO 2002c) surged during the 1980s and 1990s and now support the most important fisheries in the area. Harp seals increased in abundance from fewer than 2 million individuals in the early 1970s to more than 5 million in the late 1990s (Healey and Stenson 2000; Stenson, et al. 2002). Capelin have been found in much reduced quantities in offshore acoustic surveys since the early 1990s, but indices of capelin abundance in the inshore have not experienced similar declines, leaving the status of capelin uncertain and controversial (DFO 2000, 2001b).

The waters of eastern Newfoundland have been fished for centuries, primarily for Atlantic cod but with an increasing emphasis on other species during the latter half of the 20th century. These fisheries have undoubtedly had an influence on both the absolute abundance of some species and the abundance of species relative to one another. However, the role of the fisheries in structuring the ecosystem is often difficult to distinguish from the role of changes in the physical environment.

The marine environment off Labrador and eastern Newfoundland has experienced considerable variability since the start of standardized measurements in the mid-1940s (Colbourne and Anderson 2003; Colbourne 2003) (Fig. A3.1). A general warming phase reached its maximum by the mid-1960s. Beginning in the early 1970s there was a general downward trend in ocean temperatures, with particularly cold periods in the early 1970s, early to mid-1980s and early 1990s. Ocean temperatures started to warm in 1995. The decade of the 1990s experienced some of the greatest extremes, with particularly cold conditions in 1991 and very warm conditions in various years of the late 1990s. There have also been extremes within a year, as illustrated by the particularly cold winter and unusually warm summer/autumn of 2003.

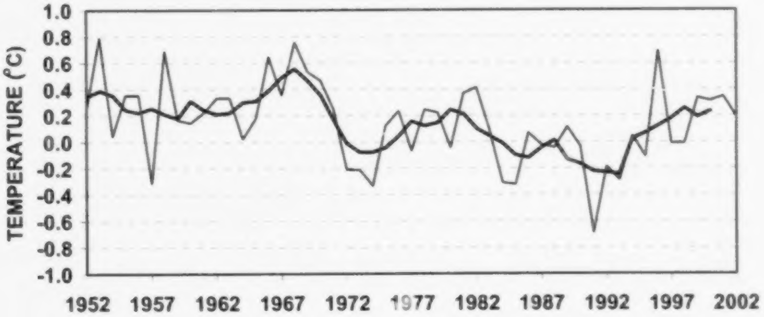


Fig. A5.1. An index of temperature. The light line shows the annual depth-averaged (0-176 m) temperature anomalies from Station 27, near St. John's. (See Fig. 1g for location of Station 27.) The heavy line is a 5-year running mean. (from Colbourne 2003) Additional indices of temperature and ice coverage are available.

The decline in water temperature during the last three decades of the 20th century was associated with an intensification of the Icelandic Low. An expression of this low that has commonly been used to correlate with physical and biological charateristics of the ecosystem is the sea-level air pressure difference between the Icelandic Low and the Bermuda-Azores High (the North Atlantic Oscillation or NAO). Off southern Labrador and northeastern Newfoundland, there is a well documented link between the positive phase of the NAO and intensified northwesterly winds, lower air temperatures, lower water temperatures and more extensive ice cover (Colbourne et al. 1994; Mann and Drinkwater 1994; Narayanan et al. 1995). These associations have become less clear since the late 1990s as the Icelandic low has been centred more to the east in some years.

Changes in the biological components of the ecosystem off northeastern Canada have been variously ascribed to overfishing, climate variability, changes in predation pressure or a combination of these factors. The relative importance of fishing and environment is difficult to determine for any species or group of species, so it is perhaps not surprising that the importance attributed to each has varied among studies. It is also perhaps not surprising, given the differences among species in the magnitude of fishery removals relative to stock size, that opinion tends to favour fishing as the dominant factor for some species and environment as the dominant factor for others. For demersal fish, there are many statements to the effect that declines were caused entirely by overfishing. Nevertheless, there is evidence that changes in oceanographic properties contributed to changes in distribution and declines in productivity (including decreased individual growth rate and possibly decreased recruitment and increased mortality). For crab and especially shrimp, it has been suggested that increases in biomass were simply a consequence of a release in predation pressure from Atlantic cod and perhaps other demersal fish, but again there is evidence that changes in oceanographic factors contributed to an increase in reproductive success. For capelin, most information supports the hypothesis that fishing had little impact on population dynamics, and that environmental factors were the primary determinant of stock size, well-being (growth and condition), distribution and timing of migrations.

A5.2 Environmental conditions and the collapse of 2J3KL cod

As with most heavily fished stocks, it is difficult to distinguish the influence of climate variability from the influences of intensive fishing and interactions with other species, both predators and prey. For the cod off Labrador and eastern Newfoundland, the fishery was clearly the major factor in the decline during the latter half of the 20th century. For the ultimate collapse, there is controversy as to whether there was a rapid but progressive decline from the mid-1980s onward or a precipitous decline during the early 1990s (Atkinson and Bennett 1994; Shelton and Lilly 2000). The former would imply that the estimates from research vessel surveys were severely positively biased for several years. The latter would imply that a very large quantity of fish unaccountably disappeared, either from greatly increased natural mortality or from greatly increased unrecorded fishing mortality (including perhaps both under-reported catches and non-reported discards). Many studies (e.g. Hutchings and Myers 1994a; Myers and Cadigan 1995; Hutchings 1996; Myers et al. 1996 a,b, 1997 a,b; Haedrich et al. 1997) have concluded that the collapse was caused entirely by fishing activity (landed catch plus discards). However, several authors point to various ways in which the decline in water temperature might have contributed to the collapse, either directly by reducing productivity (Mann and Drinkwater 1994; Drinkwater 2000, 2002; Parsons and Lear 2001) or indirectly by affecting distribution (Rose et al. 2000). See also Rice (2002) for an overview.

The severe decline of Atlantic cod in the Newfoundland-Labrador area seems to have occurred from north to south. On the northern and central Labrador shelf (Div. 2GH) catches of 60-90,000 t were reported in the period 1965-1969, but catches declined to less than 5,000 t in most years during the 1970s and early 1980s, to less than 1,000 t during the latter half of the 1980s and to zero in 1991. There appear to be no analyses of factors that contributed to the decline in this northern area. In the area from southern Labrador to the northern Grand Bank (Div. 2J3KL), catches declined during the 1970s, improved during the 1980s, and then declined precipitously in the late 1980s and early 1990s. The period of the collapse was accompanied by a dramatic change in distribution of Atlantic cod in Div. 2J, 3K and northern 3L. The autumn research vessel surveys, winter acoustic surveys and the distribution of the winter/spring trawler fleet all indicated that the fish disappeared first from the north and west, became increasingly aggregated near the shelf break in the south and east, and finally disappeared almost completely by 1994

(Baird et al. 1992b; Lilly 1994; Kulka et al. 1995b; Wroblewski et al. 1995b; Rose and Kulka 1999). There has been controversy regarding whether this change in distribution pattern resulted from a southward shift in distribution or a pattern of fish dying out in a sequence from north to south. Various analyses have been presented in support of the hypothesis that at least some of the cod shifted southward, possibly in response to a decline in water temperature (deYoung and Rose 1993; Rose et al. 1994; Atkinson et al. 1997; Rose et al. 2000) or a southward shift in the distribution of capelin (Rose et al. 2000). Indeed, Rose et al. (1994) indicated that this final shift in the late 1980s and early 1990s was part of a pattern of north/south displacements of several degrees of latitude in response to warming and cooling of water temperature. Other analyses found no support for the southward shift hypothesis (Hutchings and Myers 1994a; Hutchings 1996; Myers et al. 1996a). It is important to know whether a southward shift actually occurred, because it is postulated that such a shift made the cod more accessible to fisheries as the stock declined (Rose and Kulka 1999; Rose et al. 2000), and because the more southerly distribution placed the cod in a position that is hypothesized to be disadvantageous for successful reproduction (deYoung and Rose 1993; Rose et al. 1994; Rose et al. 2000).

Temperature and other oceanographic factors have been shown or hypothesized to have influenced various elements of productivity (recruitment, individual growth and mortality) in the Atlantic cod off southern Labrador and eastern Newfoundland. Recruitment may be affected by the magnitude of the spawning stock and two easily measured oceanographic variables, temperature and salinity. Numerous studies have demonstrated a positive association between spawning stock biomass and recruitment (e.g. Rice and Evans 1988; Myers et al. 1993a; Hutchings and Myers 1994a; Morgan et al. 2000). However, Drinkwater (2002) pointed out that both spawning stock biomass and recruitment experienced a long-term decline from the 1960s to the late 1980s, and that a statistical demonstration of the influence of spawning biomass on recruitment does not hold if the data are first-differenced to remove trends. With respect to environmental influences, there is expectation that recruitment in 2J3KL cod might be positively influenced by warm temperatures, because the stock is at the northern limit of the species' range in North America (Planque and Frédou 1999), but there have been conflicting reports of whether such a relationship can be detected (deYoung and Rose 1993; Hutchings and Myers 1994a; Taggart et al. 1994; Planque and Frédou 1999). Similarly, a reported relationship between recruitment and salinity (Sutcliffe et al. 1983) was subsequently supported (Myers et al. 1993a) and later rejected (Hutchings and Myers 1994a; Shelton and Atkinson 1994) as data for additional years became available. With respect to individual growth, a negative impact of temperature has been well documented (Krohn et al. 1997; Shelton et al. 1999). With respect to mortality, the possible influence of cold water is of considerable interest because of an apparent coincidence between the rapid disappearance of cod from research surveys and the low temperature and extensive ice cover of the early 1990s. While it seems unlikely that significant numbers of fish died as a direct consequence of exposure to cold water, there is still insufficient evidence to reject the possibility that the cold water and extensive ice cover led to a reduced duration of feeding opportunity, which itself led to poor body condition and death (Dutil and Lambert 2000; Lilly 2001).

The question of whether there was an increase in natural mortality in the 1980s and early 1990s, and whether any such increase was related to environmental factors, is of great importance to understanding the dynamics of Atlantic cod and other demersal fish (Lilly 2002; Rice 2002). As noted above, it is difficult to account for all the Atlantic cod that disappeared from the system without invoking either a considerable increase in non-reported fishing mortality or an increase in natural mortality. A similar controversy surrounds the American plaice stock off Labrador and northeastern Newfoundland (SA 2 + Div. 3K), which declined to a very low level through the 1980s and early 1990s, a period during which reported catches were low (Bowering et al. 1997). Hutchings (1996) presented a scenario illustrating how substantial quantities of American plaice may have been caught and discarded in the Atlantic cod fishery, but Morgan et al. (2002) re-examined his analyses and concluded that fishing was not the cause of the decline. Most other species of demersal fish, including many of no commercial value, declined dramatically through the same period. It has been stated that fishing was the cause of all these declines (Haedrich and Fischer 1996; Haedrich and Barnes 1997; Haedrich et al. 1997). However, the available data consist of indices of stock abundance and estimates of removals by the fishery, with little or no information on discards and incidental fishing mortality, so it is not possible to ascertain either the number of fish initially in the water or the number killed by the fishery. Under such circumstances, it remains somewhat a matter of faith to ascribe the declines entirely to fishing and to reject the possibility that natural mortality increased.

References

The references in this Appendix are included in the list at the end of the major portion of this paper.

Appendix 6. Factors influencing the re-building of 2J3KL cod

[This Appendix is reproduced from Lilly and Murphy (2004). It is an overview that was initially prepared for the Canada – Newfoundland and Labrador Action Team for Cod Recovery.]

The question of why cod stocks have not recovered since the imposition of moratoria in the early 1990s was addressed during the February 2003 cod zonal assessment meeting (Rice and Rivard 2003; Rice et al. 2003). Some generalities were identified. However, there is as yet no detailed critique of all factors that have been postulated to have been instrumental in impeding the recovery of 2J3KL cod. This section provides a brief overview of some of the processes and agents that may be affecting reproduction, growth and mortality. In some cases, a distinction is made between the offshore and the inshore.

A6.1 Reproduction (to the start of the benthic juvenile stage)

The level of recruitment to the start of the benthic juvenile stage will be affected by the number and quality of eggs produced by the stock, and by the survival of eggs, larvae and pelagic juveniles.

A6.1.1 Reproduction in the offshore

As noted in the status section, recruitment in the offshore has been very low since the early 1990s.

A6.1.1.1 Egg production

It is expected that the number of eggs produced by the stock will be small because of the low spawning stock biomass (SSB) and the high proportion of first-time spawners in the population. That is, the expectation of a strong year-class is low.

We would like to know whether the number of recruits produced by the stock during the collapse period has been as high as might be expected, given the low stock size. That is, are there factors other than the low SSB contributing to low recruitment to the early juvenile stage?

There are suggestions that fishing activity has disrupted the spawning behaviour of cod and thereby caused a reduction in the number and quality of fertilized eggs released into the sea. It is known that trawling disrupts spawning aggregations (Morgan et al. 1997) and chronic stress in the laboratory can reduce reproductive output (Morgan et al. 1999), but it is very difficult to determine whether trawling on spawning shoals of northern cod has been sufficiently disruptive to reduce their spawning success. It may be noted that there has been no directed trawling for cod during the moratorium period, but shrimp trawlers may operate in areas where cod are spawning.

There is evidence that populations have lower reproductive success at low population size due to a variety of phenomena that are not in play when the population is larger. These phenomena, collectively referred to as Allee effects, include difficulty in finding a mate and breakdown in social structure and migration patterns. It is not known if such effects have been influential in 2J3KL cod.

A6.1.1.2 Survival of eggs and larvae

Survival of cod eggs and larvae is likely to vary over time and space. The low number of spawners since the mid-1990s and their relatively small size will reduce the temporal and spatial scale over which the eggs are released, and contribute to a lower likelihood that a good proportion of eggs and larvae will find suitable conditions. A more explicit variant of this concept is the "right site" hypothesis advanced by DeYoung and Rose (1993). They contend that Hamilton Bank is an advantageous site for release of northern cod eggs, and that the more southerly distribution of cod during the 1990s was disadvantageous because of an increased likelihood that the eggs would be advected off the shelf.

Predation on cod eggs and larvae: It has been hypothesized that part of the reason why large, dominant species such as cod have been successful is that their adults crop down forage species. When abundance of the adults of the large species is severely reduced, then the forage species may increase in abundance due to reduced predation pressure. The forage species then keep the once dominant piscivore in low abundance by preying on its early life stages (eggs, larvae or juveniles) or by competing with them for food. There is not a lot of direct dietary evidence for such a phenomenon, but there is evidence for predation by herring and sprat on cod larvae and especially cod eggs in the Baltic Sea. For the southern Gulf of St. Lawrence, a reciprocal relationship between biomass of pelagic fish (herring and mackerel) and recruitment of cod supports the hypothesis that predation on early life stages is impeding recovery of the cod in that area (Swain and Sinclair 2000).

For the 2J3KL area, there is no evidence that any planktivorous finfish has benefited from the collapse of cod, but there has been a surge in snow crab and especially northern shrimp. It is not clear that the surge of these species was related solely to a release in predation pressure from cod (Lilly et al. 2000b), but in any event there remains the possibility that snow crab larvae and northern shrimp may be preying on cod eggs and larvae. In addition, Anderson and Rose (2001) drew attention to the increase in Arctic cod off eastern Newfoundland during the 1990s (Lilly and Simpson 2000). Although this increase is more likely to have been related to a decrease in water temperature than to a decline in predation from cod, there remains the possibility that Arctic cod might have had a negative influence on cod because they competed with the cod for food or they preyed on larval or early juvenile cod. In the past few years, mackerel and billfish, both of which are summer migrants from the south, have been more abundant in inshore Newfoundland waters than they were for many years, and these also could be preying on cod eggs and larvae. In summary, there is a possibility that an increase in mortality rate of cod eggs and larvae is contributing to the non-recovery of 2J3KL cod, but there are no diet data to test the hypothesis, and there has been no increase in those species (such as capelin and herring) that are most likely to prey on cod eggs and larvae.

Prey for larvae and pelagic juveniles: There is very little information on trends in the abundance and distribution of the prey of larvae and pelagic juveniles. There have certainly been changes in the overall biomass and species composition of the phytoplankton and zooplankton in the waters off Labrador and eastern Newfoundland, but the implications for cod are not well understood.

The information that bears most directly on this issue comes from pelagic net surveys conducted during 1994-1999 (Colbourne and Anderson 2003). It was found that the biomass of zooplankton and the abundance of pelagic juvenile cod on Grand Bank were very low in 1994, but that they increased as the waters warmed during the mid- to late 1990s. The abundance of pelagic juvenile cod did not increase until 2 years or so after the zooplankton started to increase. This is interpreted as evidence that the cold conditions of the early 1990s were inhibiting recruitment of cod, and that warm conditions were necessary but not sufficient for improved recruitment. Good feeding conditions were also necessary.

A6.1.2 Reproduction in the inshore

The time-series of the sentinel surveys and the inshore SPA are too short to assess whether recruitment since 1992 has been good or bad relative to levels before 1990. Recruitment was better in the late 1990s than in the mid-1990s. This may have been related to the warmer water in the late 1990s, as discussed above.

A6.1.3 Summary of factors affecting eggs, larvae and pelagic juveniles

As noted above, the major factor contributing to poor recruitment to the end of the larval stage has been the very low level of the spawning stock biomass (SSB). There is evidence from pelagic surveys that temperature and food availability for larvae or pelagic juveniles have also been important.

The pelagic surveys have been discontinued. It is difficult to detect factors affecting specific early life stages in the absence of surveys directed at obtaining indices of abundance for those stages. Note that it would be possible to determine if the production of older recruits (age 2 or 3) were good or poor relative to the size of the SSB if there were an accepted SPA spanning the pre and post-collapse periods. In such circumstances, one might use the ratio of recruits to SSB (or some such index) to assess the productivity of the stock.

A6.2 Individual growth

Prey: The trend in biomass of capelin, historically the major prey of cod in 2J3KL, has been uncertain since the late 1980s. (Biomass estimates from hydroacoustic surveys in the offshore have been much lower since the early 1990s compared with the 1980s, but indices of capelin biomass from the inshore have not shown such extensive declines.) Some studies of cod condition and feeding indicate that cod may not be faring well in certain seasons and areas, and that this is due to low availability of capelin (Rose and O'Driscoll 2002). Other studies and observations do not suggest any concerns at present about cod growth or condition (Lilly et al. 2003). Whatever the present circumstances, there remains concern that there may not be sufficient capelin to support a recovery of the cod stock, especially in the offshore and in the north (DFO 2003). (See Appendix 8 for additional information on capelin.)

A6.3 Natural mortality

A6.3.1 Natural mortality in the offshore

As noted in Section 7.1.3 of the main paper, the total mortality of fish in the offshore has been very high since the start of the moratorium. Reported by-catches in the offshore have been small, so considerable attention has focused on the possibility that natural mortality is high. Most attention has focused on the impact of predators.

A6.3.1.1 Predators

Most attention has focused on seals. The harp seal population has increased since the 1970s and estimates of consumption of cod by harp seals since the early 1990s appear high compared with the perception of cod stock size. It appears that predation by harp seals could be the major factor contributing to high mortality in the offshore, but little is known about harp seal diet in the offshore. Hooded seals may also be important predators on cod, but there are no estimates of their removals. There are also no estimates of removals by cetaceans, including minke whales and various toothed whales (e.g. pilot whales and porpoises). Various finfish are also known to feed on juvenile cod, but these species are depressed in abundance.

A6.3.1.2 Prey

As noted above, some scientists are of the opinion that cod have been in poor condition in recent years, and that this has been caused by low availability of capelin. It is postulated that this low condition has resulted in higher over-wintering or spawning mortality.

A6.3.2 Natural mortality in the inshore

As noted in section 7.2.1.3 of the main paper, tagging studies provide evidence for high natural mortality of adult cod in the inshore, especially in 3K.

A6.3.2.1 Cold water and ice

A mass natural mortality of about 800 t of cod occurred in Smith Sound during April 2003. Although the cause of this event is not fully understood, it was clearly related to unusually cold temperature (Colbourne et al. 2003). This was an important event, but the recorded deaths amount to less than 5% of the biomass of cod that was estimated to be in Smith Sound during an hydroacoustic survey in January 2003.

Mass mortalities in shallow water occurred in several locations in Notre Dame Bay and Bonavista Bay during 1998-2000 (Lilly et al. 1999, 2001). These mortalities are understood to have been much smaller than the mass mortality in Smith Sound, and occurred when the inshore populations were larger. It is therefore thought that they would not have had a significant impact on the inshore cod as a whole, but they may have been important for local components that were much smaller than the Smith Sound population. The relative importance of seals and ice in causing mortality during these events is discussed in section A6.3.2.2.

A6.3.2.2 Predators (notably seals)

There are numerous predators on cod in the inshore, including squid, several species of fish, and cetaceans. However, most attention has been focused on harp seals because of their abundance and large individual size.

The following discussion of seal-cod events is taken from Lilly (2004).

Reports of cod in shallow water became frequent in the winters of 1997-1998, 1998-1999 and 1999-2000. These reports came primarily from two areas: Notre Dame Bay on the northeast coast and southwestern Bonavista Bay on the east coast. [See Lilly et al. (1999) for a brief catalogue of some of the earlier events.]

Reports from Notre Dame Bay included the following. From January 11 to approximately January 16, 1999, cod were found dead and dying in and below ice in Virgin Arm. It was estimated by Fishery Officers, who interviewed divers and other people who harvested the fish, that perhaps 200,000 lbs (91 t) of cod died. A sample (n=193) of these fish, obtained by divers, had a mean length of 59 cm (range 35-95 cm). The fish were to all appearances healthy and in good condition. Harp seals were reported in the area and some of the larger cod in the sample had bites taken from their bellies.

Reports from southwestern Bonavista Bay were more frequent and included numerous descriptions of predation by harp seals on cod. In early February, 1998, many dead cod were observed in Southern Bay Reach. Many harp seals were reported in the area. From February 28 to March 3, 1998, cod were seen swimming with fins above the surface, and 200 lbs of cod were found dead on the shore. Seals were reported in the area and an observer reported seeing a seal taking a bite out of a cod's belly. On January 11-13, 1999, many cod were observed swimming near the surface at Cannings Cove and Jamestown. Seals were again seen in the area and an observer reported seeing seals with cod in their mouths, shaking the cod and tearing out the guts. On January 20, 1999, an observer saw a very large number of seals near Deer Island (at the headland between Goose Bay and Sweet Bay) coming to the surface with cod in their mouths. They would take a clean cut out of the belly, taking the liver but leaving the gonad. As reported by The Telegram (St. John's, NL, February 23, 1999), in February 1999 seals were observed preying on cod in a small cove on Deer Island. The seals would shake the cod "and the gut would stay in the mouth and the fish would fly off". The presence of large numbers of dead cod on the bottom was confirmed by a diver. One cod recovered with a large bite from its belly was reported to be about 3 feet (91 cm) long.

Observers say that they never before experienced incidents such as the above.

The following is a brief overview of information gleaned from newspaper accounts and reports by fishery officers and DFO scientific staff.

Observations of seals preying on cod by belly-feeding have been reported mainly from early winter to early spring and mainly from Notre Dame Bay (NDB), Bonavista Bay and Trinity Bay.

There have been several instances in which divers have reported cod lying on the bottom with holes in their bellies. There have been several well-documented incidents from eastern Notre Dame Bay and southwestern Bonavista Bay in which cod have been found milling about lethargically in cold shallow water. In some of these incidents seals have been observed on the periphery, especially near dawn and dusk. The most notable such incidents occurred at Virgin Arm in NDB in 1999 and at several locations in southwestern Bonavista Bay in 1998-2000. These incidents have generally occurred adjacent to deep water where the cod may have been overwintering. Some people think the cod were herded by the seals into the shallow water, where some of the cod then died from seal predation and perhaps from exposure to the cold water and ice. Cod have been harvested in a few of these situations and most such cod have been lethargic but alive. If cod die from exposure to cold and ice after fleeing from seals, then such mortality may be considered "fatal harassment" (McLaren et al. 2001). Another possible cause of incidents where cod have been found milling about in cold shallow water is that the cod entered the shallow water for some other reason, such as the pursuit of prey. Seal predation associated with such incidents might be opportunistic. Observations of belly-feeding continue to the present. There have been no recent reports of "events" as dramatic as those that occurred during 1998-2000.

There is evidence that natural mortality of adult cod has been high in Notre Dame Bay and Bonavista Bay. The opening of a cod-directed fishery in the inshore during 1998-2002 provided an opportunity to conduct tagging studies with the intent of estimating exploitation rates. After several years it became apparent that the returns of tags applied during specific tagging studies had declined very rapidly over time in Div. 3K (Brattey and Healey 2003). This trend was less dramatic in Bonavista Bay, and even less so in Trinity Bay. An exploration of the magnitude of natural mortality that would be consistent with such rapid disappearance of fish (Cadigan and Brattey 2003) concluded that natural mortality was likely as high as 55% per year in Div. 3K and 33% in Div. 3L as a whole

References

The references in this Appendix are included in the list at the end of the major portion of this paper.

Appendix 7. The role of predators, especially seals, in the dynamics of cod since the mid-1990s

[This Appendix is reproduced from Lilly and Murphy (2004). It is an overview that was initially prepared for the Canada – Newfoundland and Labrador Action Team for Cod Recovery. It was written as a series of short paragraphs, and retains that style. G. Stenson (Fisheries and Oceans Canada, St. John's, NL) provided some of the information.]

The predators of cod tend to change as the cod grow (Pálsson 1994; Bundy et al. 2000). Very small cod are eaten by squid, various groundfish (such as sculpins) and some seabirds. Larger juveniles are eaten by various groundfish (most notably Greenland halibut and cod), harp and hooded seals, certain toothed whales (e.g. harbour porpoise, pilot whales) and likely minke whales. Large cod probably have few natural predators, but seals can prey upon them by belly-feeding.

The predator that has received most attention is the harp seal. The harp seal population declined during the 1950s and 1960s because of heavy hunting and reached a minimum of fewer than 2 million individuals in the early 1970s. The population then increased to about 5.2 million by 1996 (Healey and Stenson 2000). Larger harvests in recent years have kept the population relatively stable at this level.

It has been estimated that harp seals consumed about 3,060,000 t of prey in 2J3KL and 3Ps in 2000. This is about 40% of the annual consumption of prey by the harp seal population. Approximately 50% of the annual consumption is taken in the Arctic and approximately 10% is taken in the Gulf of St. Lawrence.

Cod is a minor prey of harp seals (Hammill and Stenson 2000). The harp seal diet, as reconstructed from the hard parts of prey found in their stomachs, is mainly plankton-feeding pelagic fish. The dominant prey in 2J3KL are capelin, Arctic cod, sand lance and herring.

The quantity of cod consumed by harp seals has been computed using harp seal population numbers, energy requirements of individual seals, the average duration of seal occurrence within 2J3KL, the relative distribution of seals between inshore and offshore, and average diets compiled for the inshore and the offshore.

Based on the average diets, it was calculated that harp seals consumed 37,000 t of cod in 2000 (with a 95% confidence interval of 13,000 – 62,000 t) (Fig. A7.1).

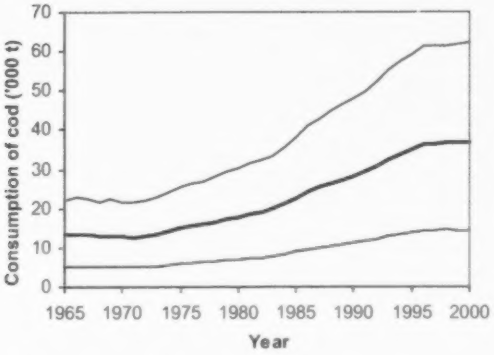


Fig. A7.1. Consumption (with 95% confidence intervals) of cod by harp seals in 1965-2000, based on diets averaged over 1982 and 1986-1998.

The only factor affecting among-year differences in these estimates of cod consumption is the estimate of harp seal population numbers. Consumption of cod has also been estimated using annual diets, but the large uncertainty associated with the yearly diets results in consumption estimates that are not significantly different from those computed using average diets.

Consumption estimates are imprecise due mainly to geographic, seasonal and annual variation in the diet. An important source of uncertainty is the relatively small number of harp seals that have been sampled in the offshore. In addition, the majority of those samples were obtained prior to the mid-1990s, and may not reflect more recent feeding.

The cod represented in the stomach contents of harp seals tend to be small, as indicated by the sizes of the cod otoliths (earbones). Most cod eaten from 1986 to 1996 were of ages 0 and 1, but in 1997 and 1998 older cod were dominant. It is thought that most otoliths come from cod that have been swallowed whole.

Larger cod may fall prey to belly-feeding, wherein the seal takes a bite from the cod's abdomen, consuming the liver and some of the other abdominal organs, but generally leaving the muscle and head. Instances of belly-feeding will usually not be detected by stomach content analysis. The weight of fish killed during such an incident is much greater than the weight of fish consumed.

Observations of belly-feeding have been reported mainly from early winter to early spring and mainly from Notre Dame Bay (NDB), Bonavista Bay and Trinity Bay (Lilly et al. 1999). There have been numerous reports of seals seen biting the abdomen of a cod, and there have been several instances in which divers have reported cod lying on the bottom with holes in their bellies. There have been several well-documented incidents in which cod have been found milling about lethargically in cold shallow water. In some of these incidents seals have been observed on the periphery, especially near dawn and dusk. The most notable such incidents occurred in Virgin Arm in NDB and several locations in southwestern Bonavista Bay in 1998-2000. These incidents have generally occurred adjacent to deep water where the cod may have been overwintering. Some people think the cod were herded by the seals into the shallow water, where some of the cod then died from seal predation and perhaps from exposure to the cold water and ice. Cod have been harvested in such situations and most such cod have been lethargic but alive. If cod die from exposure to cold and ice after fleeing from seals, then such mortality may be considered "fatal harassment" (McLaren et al. 2001). Another possible cause of incidents where cod have been found milling about in cold shallow water is that the cod entered the shallow water for some other reason, such as the pursuit of prey. Seal predation associated with such incidents might be opportunistic. Observations of belly-feeding continue to the present. There have been no recent reports of incidents as dramatic as those that occurred during 1998-2000.

Analyses of survey data indicate that cod in the offshore of 2J3KL have experienced very high mortality since at least the mid-1990s (Lilly et al. 2003). Very few cod survive beyond about age 5. There is insufficient direct evidence to determine incontrovertibly whether this high mortality is associated with fishing, poor condition, predation or some other factor. However, recorded by-catches of cod in domestic and foreign fisheries for other species have been small, and most information on body size indicates that the fish have not been in unusually poor condition in recent years. Thus, it has been concluded (DFO 2003) that the high abundance of harp seals at a time of low cod abundance, together with the estimates of cod consumption by seals, indicate that predation by harp seals is a factor contributing to the high total mortality of cod in the offshore. It must be recognized, however, that only a very small number of harp seals have been sampled in the offshore, and that there was only a trace of cod in their stomachs.

Analyses of tag return data indicate that adult cod in the inshore of 3K and 3L have been experiencing high mortality in addition to that caused by fishing (Cadigan and Brattey 2003; Lilly et al. 2003). This mortality is higher in 3K than in 3L. It has been concluded (DFO 2003) that the continuing presence of cod in the stomach contents of harp seals sampled inshore, together with observations of belly-feeding on adult cod, indicate that predation by harp seals is a contributor to the high natural mortality of cod in the inshore.

Predation on cod by hooded seals is less well known. The current status of the hooded seal population is not known because there has not been a population survey since 1990. Analysis of the limited number of stomach samples collected in the late 1980s and early 1990s indicates that hooded seals could be important predators on cod (McLaren et al. 2001). However, there are no data to assess the diet of hooded seals in the offshore since the northern cod population collapsed during the early 1990s.

It has been suggested that seals might detrimentally affect cod by competing with them for food. For example, capelin has historically been the major food for cod, and it has been estimated that harp seals ate about 893,000 t of capelin in 2J3KL in 2000 (Stenson and Perry 2001). However, there are numerous other capelin predators, including squid, other groundfish (Greenland halibut, American plaice), baleen whales (humpbacks, fins, seis and minkes), and birds (gannets, murres, puffins, shearwaters) (Bundy et al. 2000; Carscadden et al. 2001). In addition, harp seals, cod and numerous other predators share other forage fish, such as herring, Arctic cod and sand lance (Bundy et al. 2000). The complexity of the food web, and our rudimentary understanding of its dynamics, make it very difficult to assess the benefit that would accrue to cod from specific reductions in the abundance of harp seals.

There is evidence that seals are important contributers to the high mortality experienced by cod in 2J3KL. It has been stated that seal population numbers should be reduced to promote the recovery of seals. Arguments for and against this stance fall within the realms of conservation, ethics and international law (Molenaar 2002, 2003).

It is often assumed that a reduction in the number of seals will result in a decrease in the consumption of cod by seals and consequently an increase in the abundance of cod. As discussed in considerable detail by McLaren et al. (2001), this seems sensible, at least in the short term. That is, a sharp reduction of seal predation on cod of commercial size would immediately increase their availablity to a fishery (or increase the size of the spawning stock). Similarly, a reduction of predation on pre-recruit fish might give enough short-term relief to permit substantially more recruits to contribute to the spawning stock. However, other outcomes are possible, especially in the longer term. It must be recognized that the number or weight of cod consumed by seals may depend not only on seal abundance and cod abundance, but also on the distribution and degree of aggregation of the cod and the availability of alternate prey for the seals. There is also the possibility that cod saved from predation by seals may die from some other cause before they can contribute to a fishery or to the production of more cod.

Contrary to the assumption in the paragraph above, it has been suggested by some that a reduction in seals might actually cause a decline in cod, because the seals consume other species that prey on cod. McLaren et al. (2001) found no evidence to support such a scenario.

The high mortality experienced by northern cod in recent years is a major impediment to recovery. However, even if survival can be substantially improved, the stock will take a long time to reach a spawner biomass level of (say) 300,000 tons. This is because the stock is starting from a very low level, the small spawner stock biomass implies little likelihood of strong year-classes during the early stages of recovery, and the stock has an inherently low population growth rate because of slow individual growth and relatively late age at maturity.

References

The references in this Appendix are included in the list at the end of the major portion of this paper.

Appendix 8. The role of prey, especially capelin, in the dynamics of cod since the mid-1990s

[This Appendix is reproduced from Lilly and Murphy (2004). It is an overview that was initially prepared for the Canada – Newfoundland and Labrador Action Team for Cod Recovery. It was written as a series of short paragraphs, and retains that style. J. Carscadden (Fisheries and Oceans Canada, St. John's, NL) provided some of the information.]

Cod feed on a wide variety of prey (Lilly 1987). The major prey for small cod are planktonic crustaceans, notably hyperiid amphipods in the north and euphausiids on Grand Bank. For medium-size cod the major prey are schooling planktivorous fish. The most important of these is capelin, but Arctic cod are eaten in the north, herring are consumed in inshore waters, and sand lance are important on Grand Bank. Larger cod tend to feed on medium-sized fish and crabs, especially toad crabs and small snow crabs. Shrimp are consumed by a broad size range of cod. Cod also feed on smaller cod, but cannibalism is not an important aspect of the cod's diet.

The prey that has received most attention is capelin. The importance of capelin to cod has long been evident from the vast shoals of cod that once migrated into the traditional inshore fishing grounds to feed on capelin that had approached the coast to spawn. In addition, a compilation of diet data for a study of biomass flows (Bundy et al. 2000) concluded that capelin contributed about 60% of the diet of large (>35 cm) cod on an annual basis during 1985-1987. In recognition of such observations, early multispecies concerns focused on questions such as how much capelin could be harvested without reducing the proportion of the cod stock migrating inshore and without affecting cod productivity (for example, by causing a decline in cod growth).

Capelin has been considered a vital component of the ecosystem off Labrador and eastern Newfoundland. It is a dominant link between zooplankton and members of higher levels of the food web, including not only cod but invertebrates (notably squid), other fish (Greenland halibut, American plaice), marine mammals (harp and hooded seals and several species of whales) and marine birds (murres, puffins, gannets) (Bundy et al. 2000; Carscadden et al. 2001). Capelin occupys a similar role in other Arcto-boreal ecosystems (e.g. the Barents Sea and waters around Iceland).

Capelin was historically fished for bait, fertilizer, dog food and human consumption. Such domestic use may have reached 20-25,000 t annually.

Catches increased substantially when non-Canadian fleets began fishing capelin offshore (Fig. A6.1). Catches peaked in 1976 at about 250,000 t, but then declined rapidly. The non-Canadian fleet used midwater trawlers, and operated during the spring in Div. 3L and during the autumn in Div. 2J3K. The offshore 3L fishery closed in 1979, whereas the offshore 2J3K fishery continued at a relatively low level until 1991, after which it too was closed.

During the late 1970s Canadian fish harvesters started to fish mature capelin near the spawning beaches to supply a market for roe-bearing females. This fishery expanded rapidly, exhibited highest catches during the 1980s, and declined after 1990 (Fig. A8.1).

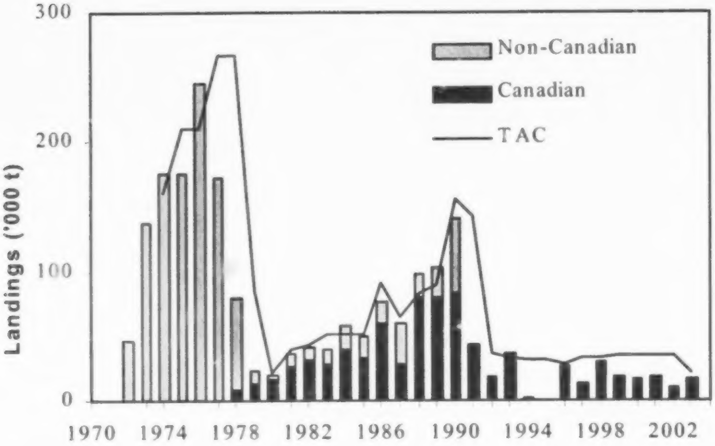


Fig. A8.1. Commercial landings and total allowable catches (TAC's) (thousands of tons) of capelin in 2J3KL. Landings are shown separately for Canadian and non-Canadian fleets. For many years capelin in SA2+Div. 3K were managed separately from those in Div. 3L.

Information on the status of the capelin stock is available since about the mid-1970s, but there is no single source of information that indicates the trend from that time to the present. The population was abundant during the mid-1970s, but declined during the late 1970s and then increased again during the 1980s. Since the early 1990s, the status of the stock has been highly uncertain (DFO 2000, 2001b). The spring offshore hydroacoustic survey in 1990 produced an estimate of 6.9 million t of capelin, whereas the estimate the following spring was about 0.1 million t. Hydroacoustic surveys and studies in the offshore have failed to find much capelin since that time. In contrast, capelin indices from the inshore (e.g. commercial catch rates; school areas derived from aerial surveys) did not show such precipitous declines.

Many inshore fish harvesters think that the capelin stock has been well below its historic abundance since the early 1990s. Others think the stock is not as severely depleted, particularly in certain areas.

Perception of capelin abundance may be influenced to some extent by the many changes in capelin biology that became apparent in the early 1990s. These include a reduction in average capelin size, late arrival in coastal waters and increased spawning in deeper water (Carscadden et al. 2002; Nakashima and Wheeler 2002). These and other changes in capelin biology were originally attributed to below normal sea temperatures during the early 1990s. However, the biological characteristics have not reverted to their former status, despite a warming during the latter half of the 1990s and early 2000s, so temperature may not have been the sole reason for the changes.

The potential for the capelin fishery to affect capelin abundance is an important consideration when one wishes to take measures to promote the recovery of cod. Many people think that the fishery has an important influence on capelin status. This perception may be based not only on the magnitude of landings, but on the dumping of males and the dumping of catches because of redfeed and other factors. However, capelin scientists concluded that there was no scientific evidence to support the perception that the capelin fishery in SA2+Div. 3KL had an impact on the population abundance of capelin (Carscadden et al. 2001). This conclusion was based on a review of information existing up to the end of the 1990s. There has been no scientific evaluation of stock status since 2000, and hence it is not possible to contemplate the extent to which exploitation has affected the capelin stock in more recent years (DFO 2001b).

The capelin stock does undergo substantial changes in biomass over time. These changes appear to be related primarily to changes in recruitment, which is influenced by wind patterns acting on spawning beaches and possibly temperature and other factors. The biomass is also influenced by the individual size of fish in the population. It has been estimated that even if there was no change in population number between the 1980s and the 1990s, the population biomass would be about 29% smaller in the 1990s due to the decline in weight of individual fish. It is also likely that the number and kind of predators could affect the survival rate of capelin (Carscadden et al. 2001).

Despite the perception of a strong dependence of cod on capelin, it has been difficult to demonstrate such a dependence with scientific data and analyses. This may be because the dependence is indeed weaker than thought, but it could also be because the data available for addressing such complex questions are insufficient and highly variable.

The role of capelin in the failure of northern cod to recover in the period since its collapse is controversial. Studies of cod condition and feeding in specific areas and seasons have been interpreted as indicating that cod have not been faring well in certain areas, most notably off southern Labrador, and that this has been due to low availability of capelin (Rose and O'Driscoll 2002). In contrast, the routine monitoring of cod during autumn research surveys in the offshore have not identified any problems with cod growth or condition in recent years (Lilly et al. 2003). Cod in the inshore appear to have been faring well. Whatever the circumstances of recent cod growth and condition, there is concern that there may not be sufficient capelin to support a recovery of northern cod to its former level of high biomass, especially in the offshore and in the north (DFO 2003).

Concerns regarding the inability of the cod stock to recover without high availability of capelin are based on the assumption that there is no species (or group of species) that can replace capelin in the diet of cod. In the Barents Sea, the growth rate and condition of cod declined considerably when capelin abundance declined during the latter half of the 1980s, but the well-being of cod declined much less during a second capelin decline during the mid-1990s. It is thought that there were more small individuals of other fish species in the Barents Sea in the mid-1990s than in the latter half of the 1980s, and that the cod were able to compensate for the low availability of capelin by preying on these other fish species rather than having to rely on crustaceans (especially hyperiid amphipods and euphausiids). In the northern cod stock area, there remains uncertainty about the status of capelin, but many people feel that the stock is less abundant than it was during the 1980s. There is no evidence that any other finfish has increased since the early 1990s when many characteristics of capelin changed. There has, however, been an increase in the abundance of snow crabs and especially northern shrimp. Before the collapse of the cod stock, both of these species were moderately important prey for cod (Lilly 1987, 1991). These species may be less valuable than capelin as prey for cod because they are digested much more slowly and have a lower fat content.

The intensity of feeding and diet composition of northern cod has been less well studied in recent years than formerly. Observations of diet have been made since the late 1990s in specific locations and times during hydroacoustic studies conducted by scientists at Memorial University, but the collection of cod stomachs during annual DFO bottom-trawl surveys was discontinued during the latter half of the 1990s after about 20 years of continuous sampling. This makes it almost impossible to discern long-term trends in the extent to which cod have been successful in finding not only capelin (Lilly 1994; O'Driscoll et al. 2000) and shrimp (Lilly et al. 2000), but also a broad variety of other prey. Consider, for example, the larger planktonic crustaceans, notably hyperiid amphipods and euphausiids. These groups have in the past been important contributers to cod diet, but we know almost nothing about the trends in their abundance and the success with which cod have been finding them in recent years. There is evidence from examination of capelin stomachs that euphausiids may have been less available in recent years than they were in the 1980s (Mowbray 2002).

Scientists advised in the late 1970s that total allowable catches of capelin be set at a conservative exploitation rate of 10% because of poor recruitment in capelin stocks at that time. The rationale for this conservative approach to exploitation was expanded in 1982 when concern was expressed for the effect that harvesting of capelin might have on cod and other predators (NAFO 1982). Canada has not had a reduction fishery for capelin. As a consequence, the fisheries for capelin off eastern Newfoundland and Labrador have been small relative to those in waters around Iceland and in the Barents Sea (Fig. A8.2).

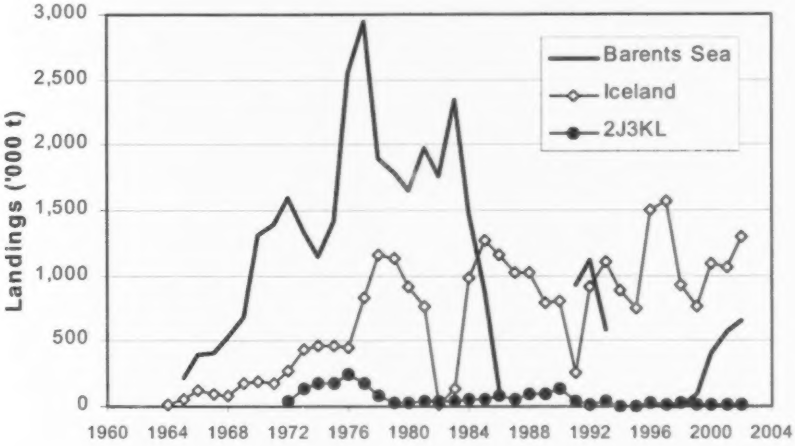


Figure A8.2. Catches of capelin off Labrador and eastern Newfoundland (2J3KL) compared with catches in waters around Iceland and in the Barents Sea. (modified and updated from Carscadden and Vilhjálmsson 2002)

Some of the text above discussed the extent to which the capelin fishery affected the status of the capelin stock, and thereby affected the quantity of capelin available to predators such as cod. There is also the question of the extent to which the capelin fishery might affect the immediate availability of capelin to cod. There have been no capelin fisheries in the offshore since 1991, so only the impact of the inshore fisheries need be considered. The inshore capelin fishery catches capelin only a short time before the capelin are ready to spawn. The immediate benefit to cod if those capelin are left uncaught is difficult to assess, because some of those capelin that are spared from the fishery would be eaten by predators other than cod (notably whales and birds). A high proportion of those capelin that survive the near-shore predator gauntlet die during or shortly after spawning. Only a portion of those dead capelin would be available to cod (because many remain on beaches, and there are many competitors for the dead capelin), and the duration of availability would be short, perhaps no more than a few hours or days. The capelin fishery would also reduce the quantity of spawn deposited on beaches and subtidal spawning grounds. Cod have been found to feed on subtidal capelin spawn, but spawn appears to be a minor component of their diet, so the impact of the capelin fishery on cod well-being through this process would seem to be small.

References

The references in this Appendix are included in the list at the end of the major portion of this paper.